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WATER CONSUMPTION IN PHILADELPHIA, according to the last annual report of the department of public works, reached the enormous average of 222 gallons per capita in 1900. The figures reported in previous years have been the talk of the country, but they were too low, owing to overestimates of population. The total consumption in 1900 was a little less than that of 1899, owing partly to measures to restrict waste, yet the reduction in population, due to the census figures, makes an apparent increase of per capita consumption of 33 gallons per day. The average daily consumption for the whole city was 287,187,630 gallons, and the population in June, 1900, was 1,293,697. The aggregate capacity of the pumping engines connected with the Philadelphia water-works at the close of 1900 was 438,040,000 gallons a day. The average cost of pumping 1,000,000 gallons 100 ft. high was $3.71. This was 81 cts. in excess of the cost for the previous year, "due to extensive repairs to pumping engines and boilers and to an increase of about 6% in the cost of coal." Of all the water pumped some 8% was lifted by water power. To raise this 5,726,000,000 gallons the turbines used 171,795,000,000 gallons. In other words, 30 gallons were required to lift one gallon. In view of the immense quantities of water pumped and wasted in Philadelphia it is no wonder the report declares the meter branch of the water department to be in an unsatisfactory condition. The few meters were, in a number of instances, found to be "in an unserviceable condition," while "the applications for meters by water consumers is greater than we are able to supply with our limited appropriation." The applicants are chiefly large consumers. It is encouraging to note the placing of some large Venturi and Ferris meters, and the ordering of still others during the year. The meters placed or purchased include one 20-in., two 30 and one 48-in. Venturi, and two 36-in. and one 48-in. Ferris. These are located on pumping mains at various stations.

MUNICIPAL OWNERSHIP OF WATER-WORKS at Los Angeles, Cal., seems to be assured. The Los Angeles City Water Co. and the city council have agreed on the sale of the works to the city for $2,000,000, subject to approval by a popular vote.

THE WATER-SUPPLY QUESTION of St. Louis, Mo., is to be studied by a commission of three engineers, just appointed by Mayor Wells. The engineers are Messrs. Allen Hazen, M. Am. Soc. C. E., New York city; Geo. Y. Wisner, M. Am. Soc. C. E., of Detroit, and Benezette Williams, of Chicago. It is said that the commission will take into consideration all phases of the much-needed improved supply, including the various propositions to that end made from time to time. An appropriation of $25,000 has been made for the investigation.

THE TWO BIDS FOR GARBAGE DISPOSAL in Manhattan, Greater New York, received on July 30, were declared informal by Mr. P. E. Nagle, Commissioner of Street Cleaning. On his recommendation the board of estimate and apportionment, the following day, reconsidered its previous vote and awarded the contract for five years to the New York Sanitary Utilization Co. at $232,000 a year. Two of the five members of the board, including Controller Coler, voted against the award. On Aug. 1 an injunction was sought, and temporarily granted against the signing of the contract. The old contract for Manhattan expired on Aug. 1, just two days after the bids were received.

A CANAL AND WATER-POWER PLANT is proposed for the Long Sault Rapids, ten miles west of Cornwall on the St. Lawrence River. It is intended to build a canal 200 ft. in length, 50 ft. wide at the bottom and 21 ft. deep, to utilize the water power. There will be three turbines of 1,000 HP. each.

THE HIGH-SPEED ELECTRIC TRACTION experiments to be made at Berlin, Germany, are reported upon as follows by U. S. Consul-General F. H. Mason, at Berlin:

There was organized at Berlin on Oct. 10, 1899, a so-called "Studien Gesellschaft," or "company for experiments," in high-speed traction. This company, which has for its president Dr. Schulz, Chief of the Imperial Railway Administration, includes as members the General Electric Co. of Berlin, Messrs. Siemens & Halske, the great machine builders Borsig, Krupp, Halzmann and Van der Zuypen & Charlier, besides several banks, which undertook to supply the capital of 750,000 marks ($178,500) for the necessary expenses of construction. The Studien Gesellschaft thus represents the foremost scientific and mechanical ability of Germany. After more than a year of study and experiment with motors, conductors, and especially the task of taking up an electrical current by a motor car moving at high speed, Director Rathenau, of the General Electric Co., in January of this year, had a formal interview with the German Emperor, in which he submitted a plan for using as an experimental electric line the military railway leading southward from Berlin to Zossen, a distance of 30 kilometers (18.6 miles). The proposition of Mr. Rathenau was promptly and fully approved, and from that moment the whole scheme has had the active support of the Imperial Government. The line to Zossen is now in process of preparation for the trials, which, it is expected, will begin in August or September. For these experiments two motor cars will be, or have been, built—one by the General Electric Co., the other by Messrs. Siemens & Halske. Each will carry about 50 passengers, and efforts will be made to attain a speed of from 125 to 150 miles an hour. Meanwhile Messrs. Siemens & Halske have been making some preliminary tests on a short provisional line, which was built for experimental purposes a year or two ago, at their works at Lichterfelde, near Berlin. The motive of these preliminary trials has been to test the important but hitherto undemonstrated point whether a motor car moving at a speed of 100 miles an hour or more will take the current readily from a three-phase line.

A HIGH-SPEED ELECTRIC RAILWAY has recently been opened between Milan and Varese, Italy. The distance of 50 miles is covered in 50 minutes, the train reaching a speed of 66 miles per hour. The third rail and four-motor cars are used. Power is obtained from the Ticino at Tornavento.

THE MONO-RAIL ELECTRIC ROAD, between Liverpool and Manchester, England, is now practically assured. The committee of the House of Commons, to which the matter was referred, has recently sanctioned the enterprise and the consent of the House of Lords was secured some time ago.

THE MOST SERIOUS RAILWAY ACCIDENT of the week occurred at Lockport, N. Y., on the New York Central & Hudson River R. R., on Aug. 4. A regular passenger train collided with an Exposition special train, resulting in the deaths of two men and the injury of one. The accident was due to a disregard or misunderstanding of orders.——Two men were killed and one seriously injured in a freight-train wreck on the Choctaw, Oklahoma & Gulf R. R., near Palestine, Ark., on July 26. The train ran into an open switch, which it is believed had been tampered with by persons intending to wreck a passenger train.

AN EXPLOSION WRECKED a block of six buildings on Locust St., near Tenth St., Philadelphia, on Aug. 5. Seven bodies have been taken from the ruins and about 50 persons were seriously injured. What the explosive was is not known, but it is believed to have been a barrel of gasolene in a grocery store. The property loss is estimated at $75,000.

A CENTRAL UNION STATION for Chicago is being advocated by Mr. T. J. Dixon, one of the aldermen, independent of the project described in our issue of May 30, but the new project is quite indefinite and no plans have yet been made. It was at first proposed to place the terminal in the new Lake Front Park, which is being established by the city for the express purpose of giving the people access to a new water front, the original water front having been occupied by the Illinois Central R. R. This plan was so strongly condemned by the public and the press that a new site was selected, and it is now proposed to establish the terminal on the east bank of the river extending from the river to State St., and from Harrison St. to 23d St. The cost is estimated at $40,000,000, but this does not include provision for the freight traffic, which is the most important consideration. The other project, already referred to, was for a site on the west bank of the river, already largely occupied for railway purposes. It includes both freight and passenger traffic, and the plans have already been worked out. A committee has been appointed by the city council to consider the entire subject, and this committee includes three railway presidents: Mr. S. M. Felton, M. Am. Soc. C. E., of the Chicago & Alton Ry.; Mr. A. J. Earling, of the Chicago, Milwaukee & St. Paul Ry., and Mr. H. B. Ledyard, of the Michigan Central R. R.

A PLATE-WAY TRACK SYSTEM was adopted in 1794 for the Ashby & Cloud Hill Ry., in England, and while the main line has long ago been absorbed by a larger railway and rebuilt, the Ticknall branch, 4¼ miles long, still remains in its original condition. The system of construction was invented by Mr. Benjamin Outram, and his recommendations were adopted by the company in spite of the objections of their own engineers, Jessop & Whitworth, who advocated the Jessop edge rail for flanged wheels. The cast-iron plates are 3 ft. long, with a rib on the inner side to keep the flat-tired car wheels on the track. They are spiked to stone blocks, giving a gage of 4 ft. 5 ins. between the ribs. When railways with edge rails were built in the same district, there was considerable trouble with interchange facilities, and in 1833 a certain part of the old line was relaid with combination or step rails, which could be used by cars with flanged or flat wheels. At the turnouts on the plate-way were pivoted wrought-iron tongues, having stems which dropped into holes in the plates. Mr. Clement E. Stretton, C. E., of Leicester, England, states that the Ticknall plate-way is operated once a year by a wagon drawn by a horse; this is done in order to hold the right of way.

A PLATE-GIRDER SWING BRIDGE has recently been completed across the Little Calumet River at Riversdale, Ill., by the Illinois Central R. R., which comprises a center girder 171 ft. 4 ins. long and two side girders, 168 ft. 4 ins. long. The girders are spaced 15 ft. 4 ins. apart and the total width of the bridge is 31 ft. 4 ins. The long middle girder is made up of a web 9-16-in. thick and 9 ft. deep at the center, with top and bottom flanges of 8 × 8 × ⅝-in. angles and two 16 × ½-in. side plates, two 18½ × ⅝-in. cover plates and one 18½ × 9-16-in. cover plate. The side girders have 7-16-in. webs 9 ft. deep at the center and chords of 6 × 6 × ⅝-in. angles reinforced by two 12 × ½-in. side plates and two 16 × 9-16-in. and one 16 × 7-16-in. cover plates.

A 21,000-TON VESSEL has been ordered, it is reported, by the Hamburg-American Line of the firm of Harland & Wolff, of Belfast. This is larger than the "Celtic" of the White Star Line, which has a tonnage of 20,880. The new boat is intended for passenger and freight service and will have a speed of about 17 knots per hour.

THE WHITE STAR LINER "CELTIC," the largest ship ever built, reached New York on Aug. 3 after a voyage of eight days from Liverpool. The average speed attained was 14.95 knots per hour, but it is said that this can be raised to 16.50 knots. The gross tonnage of the "Celtic" is 20,880, her length is 700 ft. and she is 75 ft. wide and 49 ft. deep. There are accommodations for 2,859 passengers.

AN EXAMINATION for the position of Assistant Engineer, second grade, to the Rapid Transit Commission of New York city, will be held on Aug. 14 by the Municipal Civil Service Commission at 346 Broadway, New York. The annual salary to be paid will be not less than $900 nor more than $1,200, and the subjects of the examination will be as follows. (1) Technical knowledge required for the position to be filled; (2) experience; (3) mathematics; (4) writing a report upon assumed conditions. Further information may be obtained by addressing the Secretary of the Commission, Mr. Lee Phillips.

AN AUTOMOBILE GRASS MOWER has been built by the Deering Harvester Co., of Chicago, Ill. The machine is propelled by a 4-HP. gasolene motor, and is said to have cut 22 acres in 9 hours, using a 5-ft. sickle bar. The motor is placed in front of the driver's seat and rests upon a leading third-wheel. The cutter bar is placed at the side, as is usual in horse-drawn machines. It appears to us that the traditions of the latter have been too closely followed. The cutter bar could have been placed directly in front of the machine, since there are no horses to tread upon the grass, and the driver should be given a higher seat, where he will have a better view of the ground. This construction would simplify the machine and probably make it lighter, while the cutter bar would be more manageable and subject to less danger and strain than when carried out at one side. Of course, there is always the danger to be avoided of the operator being pitched over in front of the knives by the machine striking an obstruction. There is perhaps even more opportunity for simplifying construction in applying mechanical motive power to the grain harvester.

A PHOTOGRAPHIC PLATE, 8 ft. long by 4 ft. 8 ins. wide, has recently been made by the G. Cramer Dry Plate Co., of St. Louis, Mo. This plate, which is said to be the largest ever made, is to be used in making a photograph of St. Paul and Minneapolis from a balloon.

NEW UNION PASSENGER STATION AT DAYTON, O.

The city of Dayton, O., has a very attractive appearance, resulting from its handsome buildings; its wide, clean and well-paved streets, and a general air of good municipal management. The new union station is in keeping with the general character of the city, and is exceptionally successful in its design, both in regard to its architectural treatment and to its provision for the comfort and convenience of the traveling public.

FIG. 3. VIEW OF UNION STATION, DAYTON, O.

The station is owned by the Dayton Union R. R. Co., which is in turn owned jointly by the Cincinnati, Hamilton & Dayton Ry., the Cleveland, Cincinnati, Chicago & St. Louis Ry., and the Pittsburg, Cincinnati, Chicago & St. Louis Ry. The trains of all these roads, together with those of the Erie Ry. and the Dayton & Union Ry., use the station. The Dayton & Union Ry. is a small road, only 47 miles in length, belonging to the C., H. & D. Ry. and the C., C., C. & St. L. Ry. jointly.

From the general plan, Fig. 1, it will be seen that there are six through tracks, arranged in pairs, the tracks of each pair being 12 ft. c. to c. Between the tracks are concrete platforms 15 ft. wide and 700 ft. to 1,000 ft. long, connected by a crosswalk. This walk is kept open at all times, trains in each direction being stopped only after their rear cars have cleared the crossing. There is also a stub track for the trains of the Dayton & Union R. R., as this is their terminal, and the arrangement keeps the through tracks clear. Beyond the outer platform are two through freight tracks, and beyond these are the freight yard tracks. The platforms are covered by umbrella roofs, supported by center columns and light steel trusses, as shown in Fig. 2, the hollow cast-iron columns serving as down spouts. A wider roof covers the crosswalk connecting the platforms, and has at its outer end a telegraph and dispatcher's office.

The station has two buildings, separated by a passageway 56 ft. wide, in line with the ticket gates and the street where the omnibuses and carriages stop. The main building is 215 ft. 4 ins. long and 53 ft. 9 ins. wide. It contains the general waiting room (with ticket office, etc.), 41 × 110 ft.; women's room, 20 × 25 ft.; women's toilet room, 12 × 18 ft.; men's toilet room, 17 × 16½ ft.; smoking room, 15 × 24 ft.; dining room, 18 × 20 ft.; and lunch room, 32 × 24 ft. The waiting room is very lofty, and has a vaulted ceiling. The west end of the building has an upper story, in which are the offices of the Superintendent and of the Dayton Union R. R. Co. The east end has also an upper story, in which are the kitchen and the trainmen's waiting room. In the other building, 260 ft. 10 ins. long and 45 ft. wide, are the baggage and express rooms, engine and boiler rooms, coal storage and carpenter's shop. All these have concrete floors. The current for electric lighting is furnished by two Bullock dynamos, each directly connected to a Buckeye high-speed horizontal engine. Steam for the engines and for the heating system is supplied by a battery of two Stirling water-tube boilers. All heating pipes, electric wires, etc., are laid in a subway or pipe duct, as shown by the cross-section. The water supply is obtained from the city system, and being of too hard a quality to be satisfactory for boiler use, it is treated by a purification plant on the We-Fu-Go system. Coal cars are run directly into the coal room on a spur track, the coal being shoveled out. Ashes are stored on the other side of the track, and shoveled thence directly into a car.

The station building is set back some little distance from the main street (Ludlow St.), and presents its narrow end to the street. In order to architecturally accentuate the entrance to its station grounds, the architect designed a species of colonnade, or what is technically termed a propylon, which is erected on the building line of the street. This consists of groups of stone pillars and arches, supporting a flat stone ceiling with pediments over the sidewalk entrances, and having a red tile roof. It spans the two sidewalks and the two driveways, the latter being separated by a raised part, level with the sidewalks, on which is placed a fountain presented by the city. This arrangement separates the lines of vehicles entering and leaving the station. This architectural feature cost about $10,000, and while it is not a necessity from a utilitarian point of view, the railways are to be commended for their liberality in spending this amount to erect what is an important feature in the successful artistic design of the station as a whole. Just inside the propylon is a small grass plot. Fig. 3 is a general view of the station, showing the main building and the propylon, and also the umbrella roofs over the platform, and the smokestack of the boiler house. The tracks cross the street on the level, and a watchman is stationed here to operate the gates and to stop persons from going onto the platforms from the street.

From the street sidewalk, two cement walks lead up to the station; the one nearest the tracks being a broad walk extending along the front of the building and shut off from the tracks by a high iron fence. This is covered by a shelter roof, and provided with seats placed against the fence, so that in warm weather it forms a pleasant outdoor shelter for waiting passengers, without interfering with persons going to and from the station. At first there was the usual trouble of having the walk bespattered with unseemly expectorations, but this trouble was tackled in earnest by the superintendent for the sake of appearance as well as for sanitary reasons. There is no city ordinance against expectoration in the streets, but by the use of numerous cuspidors and warning signs the trouble has been greatly abated, while persons who heedlessly offend are politely admonished by the attendants and requested not to forget what the cuspidors are for.

Gates are provided in the fence, through which passengers are admitted to the train platforms only when their particular trains are ready. Passengers arriving by the trains pass directly out of the station by the covered way between the two buildings. Here also cabs and hotel omnibuses receive and deliver their passengers, convenient to the baggage room. During the winter, a portable

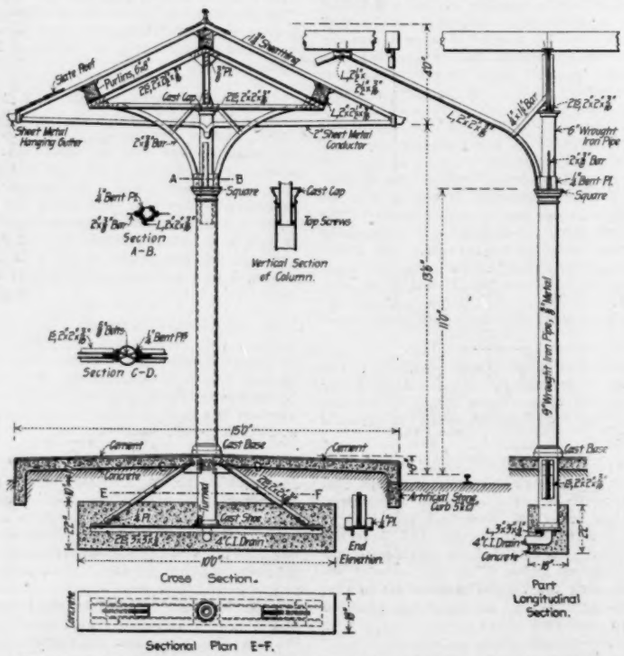

FIG. 2. CONCRETE PLATFORM AND UMBRELLA ROOF OF UNION STATION AT DAYTON, O.

wooden wall or curtain, provided with doors, is erected across this space, in line with the outer walls of the two buildings, thus preventing through drafts and excluding rain and snow.

The architectural design is on the lines of the Spanish renaissance. The exterior is of buff pressed brick, of varying shades. In the main

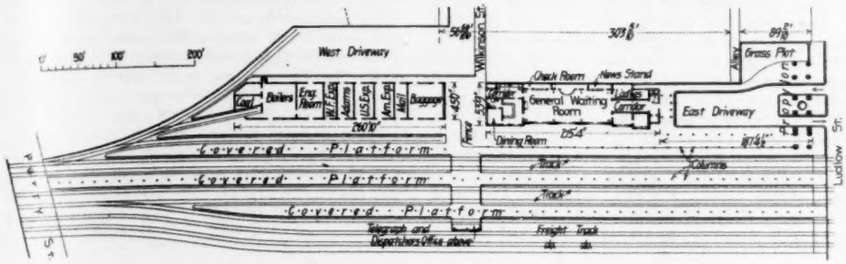

FIG. 1. PLAN OF UNION STATION AT DAYTON, O.
Elzner & Anderson, Cincinnati, O., Architects.

walls these are used at random, thus preventing too flat an appearance. For the tower, boundary wall, etc., however, where a diaper pattern is worked in (as shown in Fig. 3), the darker bricks are selected to form the pattern, while the center bricks in each panel of the diaper work also project slightly from the face of the wall. The window sills, pillars and other stone trimmings are of terra-cotta, matching the color of the brick, while the roof is of dark red Spanish tile. The tower has a clock with four 10-ft. dials.

The interior is very handsome, but simple in treatment, giving a bright and cheerful effect, and all parts can be readily cleaned. The walls and groined arches are left in the pale gray color of the plaster rough finish, which may be painted in the future if considered desirable. The tall columns which reach from the floor to the vaulted ceiling are painted white, with gilt decoration on the flutings and capitals, while the bases are bronze castings. A wainscot about 6 ft. high, of mottled green glazed tile, extends around the room, and the floor is paved with mosaic of a light color. The pillars supporting the semicircular front of the ticket office are of imitation Sienna marble, and between them is a handsome hammered iron grille, painted black. The decorations are in white and gold. All the wood trimmings, the seats, etc., are of oak, and the general effect is bright and cheerful. By day, the room is lighted by upper windows and by the numerous glazed doors in the track side of the room. At night it is lighted by electricity, there being three ornamental 25-light chandeliers and numerous side lights in wall brackets. At one end is a large fireplace with gas logs, but this is mainly for appearance, the building being heated throughout by steam. The waiting room has doors to the open air on one side only, avoiding the common but objectionable plan of placing doors in opposite sides, an arrangement which results in unpleasant through drafts and an unnecessary amount of passing to and fro. The ticket office projects outside the rear wall of the waiting room, and is lighted by a skylight in the rear, as shown in the cross-section, Fig. 4. This gives good light from behind, so that the ticket clerks can conveniently see their ticket cabinets, etc. The same arrangement is made for the news-stand and check room, which are on either side of the ticket office. The ticket office has a semicircular front with marble pillars and a grille of hammered iron, the bronze panels at the base of which are provided with four ticket windows. Fig. 5 is an interior view, looking towards the dining room, with the ticket office on the right and the doors to the platform to the left.

The toilet rooms are well arranged, equipped with open plumbing, and have marble and metal fittings throughout. The men's room has urinals and water closets, a row of wash basins (with hot and cold water), and a supply of soap and towels, all furnished free. A porter has special charge of this room and the smoking room, and keeps them tidy and clean.

The architects of the building were Elzner & Anderson, of Cincinnati; and the general contractor was S. W. Hornbrook, of Cincinnati. The total cost of the buildings was about $150,000. For plans, photographs and information we are indebted to Mr. A. O. Elzner, and to Mr. W. F. Stark, Superintendent of the Dayton & Union R. R., whose office is in the station.

FIG. 5. INTERIOR OF WAITING ROOM; DAYTON UNION STATION.

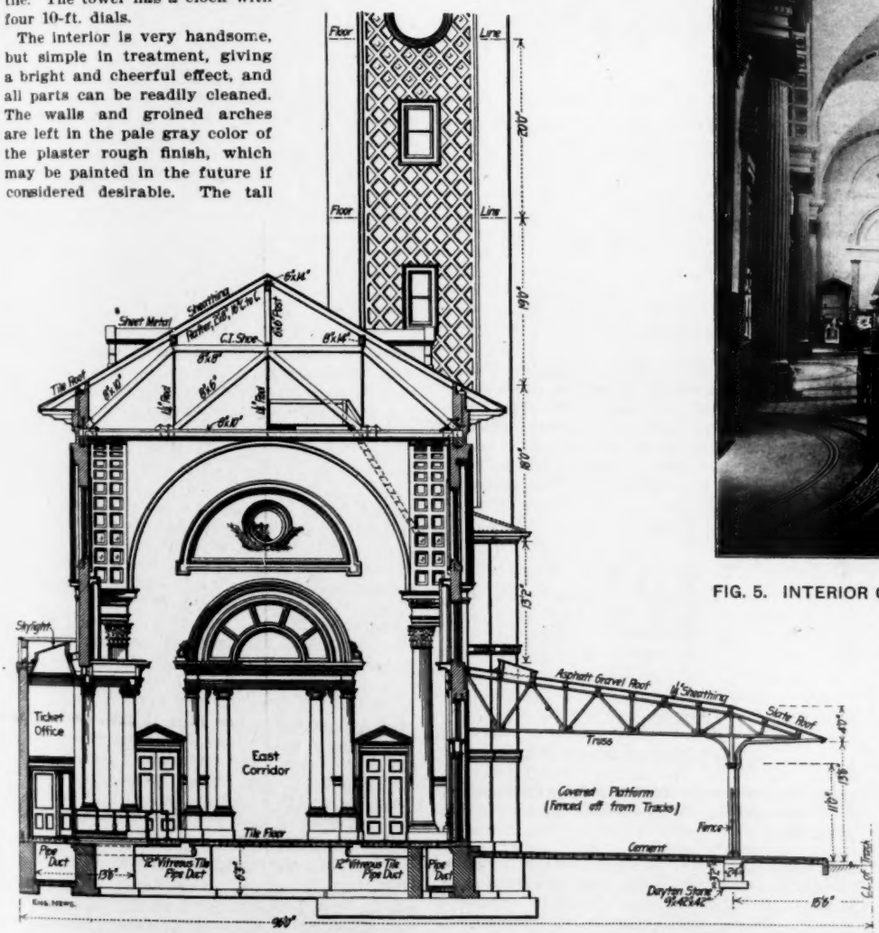

FIG. 4. CROSS-SECTION (LOOKING EAST); DAYTON UNION STATION.

A BALLOON ASCENSION to a height of 33,500 ft. was made by Dr. Suering Berson, a member of the Meteorological Institute of Berlin, on Aug. 1. A minimum temperature of — 40° F. was recorded. This is said to be the greatest altitude that has ever been reached.

A NEW HARBOR is to be made by dredging on the shore of Lake Michigan, near East Chicago, Ind., eight miles east of South Chicago. The channel will be 300 ft. wide and 20 ft. deep and the present contract provides for its extension 1,200 ft. inland. It is intended, however, ultimately to continue the channel to East Chicago. The shore at the point selected is pure sand and breakwaters and piers will have to be constructed to prevent the channel filling up after it has been dredged. The project is being carried out by the Lake Michigan Land Co., and the cost of the improvements is estimated at $200,000.

RIVETED LATTICE TRUSS DRAWBRIDGE; CHICAGO & NORTHWESTERN RY.

(With two-page plate.)

The riveted lattice type of bridge, with multiple intersections of the web members, has not come into very extensive use in this country, although it has been used on some leading railways, notably the New York Central Ry. and the Chicago & Northwestern Ry. In the present article we describe a swing bridge with trusses of this type, the trusses representing an intermediate design between the ordinary American truss and the English lattice truss, whose web members are much greater in number (with consequently more frequent intersections) than those of the bridge now under consideration. This structure is near Milwaukee, Wis., on the Milwaukee Division of the Chicago & Northwestern Ry., and carries the line across the Kinnickinnic River. It was built in 1899 to replace a single-track pin-connected bowstring bridge of 177 ft. span, built in 1880. The old bridge was moved to a temporary pier 220 ft. down the river, where it was used during the construction of the new bridge, as will be described further on. A sketch plan of the site, showing the location of the permanent and temporary structures is given in Fig. 1.

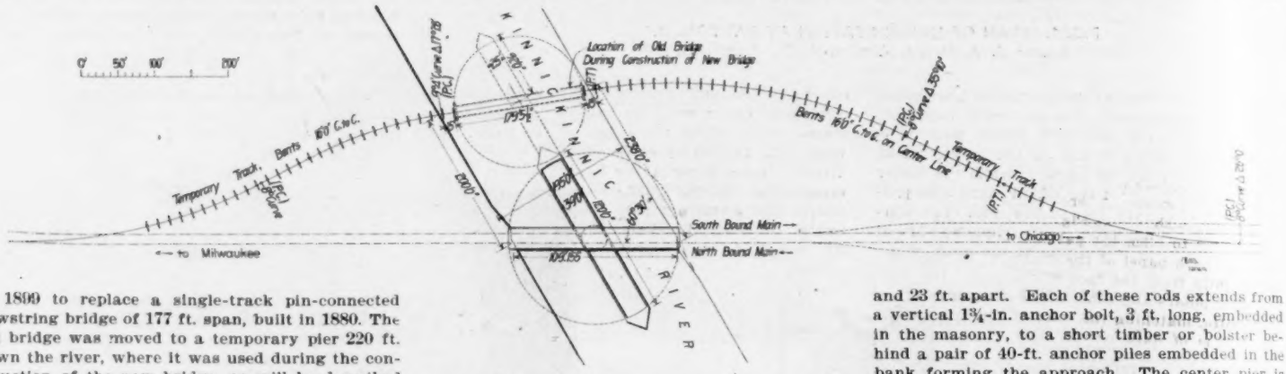

FIG. 1. PLAN OF SITE OF DRAWBRIDGE OVER THE KINNICKINNIC RIVER; CHICAGO & NORTHWESTERN RY.

In a paper read before the Western Society of Engineers describing the rebuilding of the Kinnickinnic River bridge, Mr. F. H. Bainbridge, who is now Bridge Engineer of the C. & N. W. Ry., made the following remarks:

Riveted lattice trusses are standard on this road for single track fixed bridges of 110 to 160-ft. span, and double track fixed bridges of 110 to 140-ft. span. Inasmuch as a riveted lattice span weights from 15 to 20% more than a pin-connected span designed under similar conditions, some substantial reasons should exist for using the former. These are principally that riveted lattice bridges have withstood the effects of the constantly increasing weight of rolling stock better than pin-connected bridges, and that they are less liable to be wrecked by a derailed train. In a collison on a bridge of this type at Fond du Lac, Wis., in April, 1898, a freight locomotive left the track and passed completely through the side of the bridge, severing the web members at three panel points. Nothwithstanding this, the train which the engine had been hauling was successfully drawn off the bridge, and four other trains were run over it before any repairs had been made or supports supplied. In two accidents which happened to a 117-ft. riveted lattice bridge at Daggett, Mich., a log projecting from a car struck the end post and caused the entire load of the car to shift, raking the whole side of one truss, but though web members were broken in each case, the bridge did not collapse. Some years ago Mr. Stowell, at that time bridge engineer of the state of New York, cited a number of cases in which end posts in lattice bridges had been completely broken without wrecking the structure.

In the discussion on this paper Mr. Bainbridge remarked that the failures of pin-connected bridges have been largely due to the excessive vibrations caused by the wearing of the pins, while bridges with worn pins vibrate severely under traffic. It is objected that in riveted joints carrying heavy strains there is no dependence upon the stress being carried by the whole number of rivets, but this objection is met by limiting the span and dividing up the systems so that the strains carried by each system are as small as possible. The principal reason for using the multiple intersection system is to keep the stresses small in the individual members and thus avoid so many rivets in one connection. He did not think there was more uncertainty in the stresses in a lattice bridge than in those of a pin-connected bridge.

Mr. C. L. Strobel, M. Am. Soc. C. E., said that he knew of no pin-connected bridge that had failed through the breakage of a pin. The wear from vibration is usually in the light members, such as counters and lateral rods. There is also an advantage that weakness in a pin-connected bridge is always made evident. He questioned whether a lattice bridge can be overloaded better than a pin-connected bridge. Riveted lattice bridges with short panels are exceedingly indeterminate in regard to the actual stresses in the members, and actual tests have shown that members which should be in tension are sometimes actually in compression. Owing to the large secondary stresses and to the uncertainty of the stresses, a lattice bridge should be proportioned more liberally than a bridge with a single system of triangulation.

Mr. W. H. Finley, Principal Assistant Engineer of the C. & N. W. Ry., remarked that some engineers who object to the lattice bridge will build a pin-connected bridge and rivet in the posts and hip joints, producing a hybrid sort of structure. He felt satisfied that pin-connected bridges would not have stood the damage endured by the above mentioned riveted lattice bridges at Fond du Lac and Daggett. It may be noted, however, that cases are on record of pin-connected bridges which have stood up under very severe treatment of a similar kind.

To return to the Kinnickinnic River drawbridge, this bridge was designed under the direction of Mr. E. C. Carter, M. Am. Soc. C. E., Chief Engineer, by Mr. W. H. Finley, Principal Assistant Engineer of the C. & N. W. Ry.; Mr. F. H. Bainbridge, who is now Bridge Engineer of the road, was in charge of the construction. The piling for the substructure was done by the Starks Dredging & Dock Co., of Milwaukee. The construction of the masonry and the moving of the old structure were done by the railway comoany. The superstructure was built by the American Bridge Works, of Chicago (now absorbed by the American Bridge Co.), and the operating machinery by the Vulcan Iron Works, of Chicago.

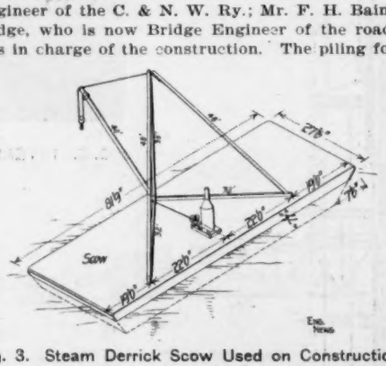

Fig. 3. Steam Derrick Scow Used on Construction of Kinnickinnic River Drawbridge; C. & N. W. Ry.

SUBSTRUCTURE.

The depth of water is about 6 ft., and an 8-in. test boring at the site showed 25 ft. of black muck, 6 ft. of old slough grass, 15 ft. of soft gray clay, 10 ins. of gray sand, 10 ft. of soft light gray clay and 18 ins. of black sand, 3 ft. 8 ins. of soft blue clay and sand, and 3 ft. 6 ins. of hard gray and gravel. The center pier and abutments were built on 60 ft. Norway pine piles, with caps and floor timbers 12 × 12 ins. The piles were cut off about 18 ft. below the water line.

The abutments are straight walls about 84 ft. long, with short wing walls and a back wall to retain the earth bank above the level of the bridge seat. The face of this back wall is curved to a radius of 117 ft. 8 ins. The abutments are 19 ft. 4 ins. high from the timber floor to the coping or bridge seat, with a width of 12 ft. at the base and 8 ft. on the coping. The river face has a batter of ¾-in. per ft. The back wall extends 6 ft. 8 ins. high above the coping, and has its top 10 ins. below the base of the rail. Each abutment is anchored by two horizontal 1½-in. rods, 34 ft. long and 23 ft. apart. Each of these rods extends from a vertical 1¾-in. anchor bolt, 3 ft. long, embedded in the masonry, to a short timber or bolster behind a pair of 40-ft. anchor piles embedded in the bank forming the approach. The center pier is circular, 35 ft. 6 ins. diameter at the base, with a height of 16 ft. 9¾ ins. The body of the pier has a central conical core of masonry and an outer shell of masonry, with a V-shaped annular space between them, 2 ft. 3 ins. wide at the bottom and 8 ft. wide under the coping, as shown in Fig. 2. The distance between the center lines of the pier and the abutments is 117 ft. 8 ins.

The foundation works and the lower portions of the masonry were built within cofferdams. That of the center pier was 52 ft. 8 ins. square outside, and had two rows of 35-ft. piles, 4 ft. 4 ins., c. to c., with two rows of Wakefield sheet piling, the space between the lines of sheet piling being filled with puddled clay. Corner braces of horizontal timbers were placed between the inside piles. For the abutments a single line of piles and Wakefield sheet piling was used.

The masonry was laid with a steam derrick scow, shown in Fig. 3. The scow was 81 ft. 9 ins. long, 27 ft. 6 ins. wide and 7 ft. 7 ins. deep. The derrick frame consisted of a post 35 ft. high, with two sills 32 ft. long, from the ends of which brace timbers 48 ft. long extended to the top of the post, having iron straps to hold the top pair. The boom was 40 ft. long. All these timbers were 12 × 12 ins., except the sills, 10 × 12 ins.

The protection pier has four rows of rock elm piles, 40 ft. long for the inner rows and 50 ft. for the outer rows. These rows are 12 ft. 4 ins., c. to c., and the piles of the inner row are 10 ft. apart, while those of the outer row are 5 ft. apart. The caps and stringers are 12 × 12 ins., and on the outer piles are two lines of waling pieces 6 × 12 and 8 × 12 ins. The rectangular portion of the pier is 240 ft. long, with triangular ends 25 ft. long, the points and corners being protected by clusters of seven rock elm piles 66 ft. long, bound with ¾-in. wire cable.

SUPERSTRUCTURE.

The general design of the bridge is shown in Fig. 4. The bridge is 215 ft. 9 ins. long, and has two trusses 27 ft. apart in the clear. These trusses are 26 ft. deep, c. to c. of chords, at the ends, and 35 ft. deep over the pier. The chords and end posts are composed of two plates and four outside flange angles, with top and bottom lacing bars and batten plates. Vertical stiffening diaphragms are fitted between the two webs of the chords, to which they are connected by vertical

angles. Over the turntable are three vertical posts in each truss. The outer ones are similar in construction to the chords and end posts, but the center posts have four web plates instead of two web plates with lacing bars in the other sides. The trusses are of the triple-intersection type, and the heavier web members consist of four angles with lacing bars between them. The lighter web members are composed simply of four angles. Large connection plates are used where the web members are connected to the chords. The portal bracing is a latticed member with curved knee-braces, while transverse lattice trusses extend between the vertical posts over the turntable. Plate girders between these posts support the operator's cabin. The top struts at panel points are composed of four angles with lacing bars.

The floor beams are plate girders, placed below the bottom chords and having their ends riveted to deep connection plates. These beams are 48 ins. deep, and have an end shear of 122,400 lbs. in the end floor beam and 135,200 lbs. in the others. Between them are riveted four lines of 26-in. plate girder stringers. The floor system consists of yellow pine ties 8 × 8 ins., 12 ft. long, with guard timbers 10 × 12 ins. along the ends. The ties are spaced 6 ins. apart in the clear, and are not boxed out over the stringers. Four planks 4 × 10 ins. are laid along each track, with an angle iron ½ × 4 × 6 ins. next to the rail, as shown in Fig. 5.

There is no circular turntable girder, but the upper track plate for the roller ring is attached to the bottom chords of the transverse distributing girders and to diagonal girders, which, together, form an octagonal frame as a substitute for the ordinary drum. The distributing girders are 57¾ ins. deep and the diameter over the octagonal framework is 29 ft. 6 ins.

The live load is taken to consist of two 131½-ton engines followed by a train weighing 4,000 lbs. per lin. ft. The dead load is taken as 4,600 lbs. per foot of the bridge. The structural material is of soft steel. All rivets are ⅞-in. diameter, with the exception of ¾-in. rivets in the bracing. All rivet holes were punched ⅛-in. small and reamed to the proper size.

The bridge was erected in place, the protection pier serving as falseworks. The turntable, floor system and bottom chord were first erected by means of a derrick, and the upper parts then erected in the usual way by the aid of a traveler.

OPERATING MACHINERY.

The machinery for turning the bridge is placed in the house over the tracks, and the general arrangement is shown in Fig. 6. As there was no electric power available, it was decided to adopt a gasoline engine, and the motive power is furnished by a 22-HP. gas engine of the Fairbanks & Morse Co.'s make, which runs at 185 revolutions per minute. The engine can only run in one direction, and two sets of gear, with friction drums and clutches, are used for connecting the engine with a train of gearing for swinging the bridge in either direction; this engine drives a shaft 2 15-16 ins. diameter, which extends across the engine house, being placed at a slight angle so as to clear the center posts of the trusses.

The pinion A on the engine shaft drives the two spur wheels B and C, which are of the same size and are geared together. On the shafts of these wheels are the smaller spur wheels D and E, which are connected or disconnected by means of clutches, so that either one (but only one) may drive the pinion F, which is keyed to the countershaft which crosses the engine house. On each end of the shaft is a bevel pinion G gearing with a bevel wheel H on top of the vertical shaft which extends down to the turntable, the foot of this shaft carrying a pinion J. This pinion is carried by a sleeve, which can be raised by a hand lever, as shown, and in the event of its being desired to operate the bridge by the hand gear. The pinion J is in mesh with a spur wheel K on the shaft which carries the rack pinion L. The hand gear consists of a shaft with a capstan head at the floor level, and carrying a pinion which gears with a spur wheel on the shaft of an independent rack pinion. There are two sets of main driving gear and two sets of hand gear. The bridge can be swung in about one minute by machinery and about six minutes by hand. The proportions of the gearing are as follows:

	No. of teeth.	Pitch of teeth, ins.	Pitch diam., ins.	Width of face, ins.
Pinion A	23	1¼	11	3½
Spur wheels, B and C	76	1¼	36	3½
" " D and E	47	1½	22.3	4
" " F	47	1½	22.3	5
Bevel pinion, G	15	2¼	11	4½
Bevel wheel, H	30	2¼	22	4½
Pinion, J	15	2½	11.94	5½
Spur wheel, K	62	2½	49.34	5½
Rack pinion, L	12	3.58	13.66	8
Rack	336	3.58	31 ft. 2.6 ins.	8

The turntable and the fixed track have forged steel treads 2 × 10 ins., between which are the 50 cast-steel rollers, 18 ins. diameter and 9 ins. wide. These are carried by radius rods attached to circular plates on the center pin and to a channel iron ring outside the rollers. The main driving gear and the clutches are shown in more detail in Fig. 7. About 62⅔% of the weight (or 400 tons) is carried on the rollers, while 33⅓% (or 200 tons) is carried by the center bearing. The arrangement of the center bearing and the rollers is shown in Fig. 8.

END BEARINGS, LOCKS AND LIFTS.

The end bearings, Fig. 9, are four cast-iron boxes, each fitted with a pair of rollers 12 ins. diameter and 11½ ins. wide, on steel axles 3 5-16 ins. diameter. The elevator may be adjusted by means of shims or packing plates under the journals and secured by set screws. The castings are secured to the masonry by four 1¼-in. bolts, 12 ins. long, the ends of which are split for 5 ins. and spread by wedges set in the bolt holes.

The end latches are on the center line of the bridge, inside the end floor beams. The latch consists of a pair of vertical bars 1 × 3 ins., 6 ft. long, between the lower ends of which is a 5½-in. roller 1¾ ins. wide. As the bridge closes, this roller runs up the inclined face of the latch casting raising the latch, which then drops into a pocket 6¼ ins. wide in the top of the casting. The latch is suspended by a short link from an arm on a 1½-in. shaft. At the center of the bridge is a similar shaft operated by a hand lever and fitted with arms which are connected to those of the end latch shaft by 1¼-in. wire ropes.

The tracks on the bridge are laid with the C. & N. W. Ry. standard 90-lb. rail, and at each end are hinged rails 15 ft. long, the ends of which are bent and planed to fit the ends of fixed rails on the approach, as shown in Fig. 10. A four-bolt splice joint is used at the hinge, the outer bolt hole in the movable rail being slotted downward to allow the rail to rise. Across the end of the bridge, just behind the foot of the end posts, is a 1¾-in. shaft, fitted with cams to raise the hinge rails and with arms to bear on the rail base and hold the rails down when the bridge is closed. The shaft is operated by a hand lever and fitted with counterweights.

TEMPORARY LINE.

During the construction of the bridge the main line was diverted to a temporary loop line, crossing the river 220 ft. below the site of the new bridge, as shown in Fig. 1. The temporary track was carried by a timber trestle with five-pile bents 16 ft., c. to c. These bents had caps 14 × 14

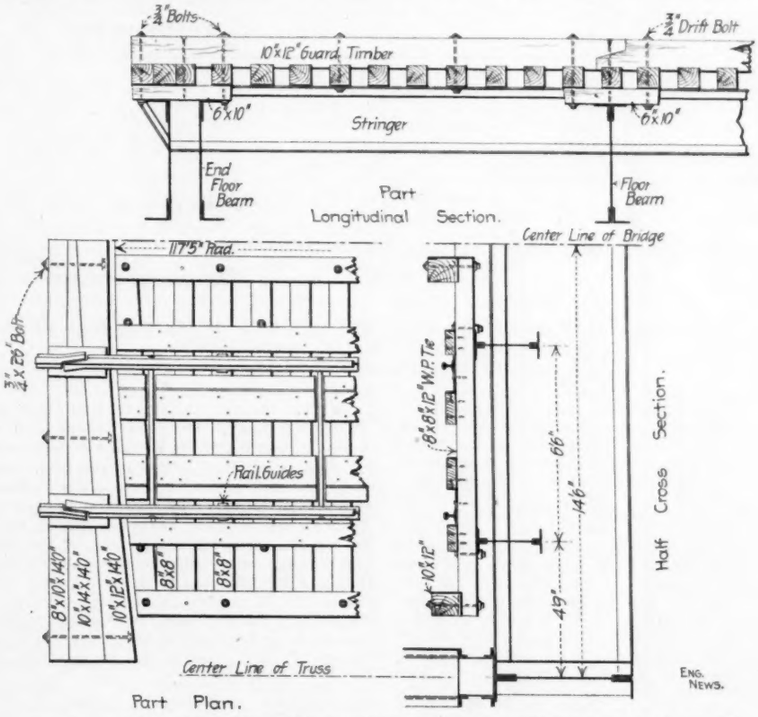

FIG. 5. FLOOR SYSTEM OF KINNICKINNIC RIVER DRAWBRIDGE; C. & N. W. RY.

ins., 14 ft. long, and braces of planks 4 × 10 ins. Under each rail was three packed stringers 8 × 16 ins., 32 ft. long, with 4-in. packing sleeves on the double rows of bolts. The inner stringers of each set were 3 ft. apart. The ties were 8 × 8 ins., 12 ft. long, 6 ins. apart, drift bolted to the stringers and bolted to the caps. On their ends were guard timbers 6 × 8 ins. On the curves of 8° and 9° 4' a superelevation of ½-in. was given to the outer rail by inclining the caps. The abutments were of pile construction with jack stringers 8 × 16 ins. on the end panel of the trestle. The center pier consisted of 69 rock elm piles 60 ft. long, with caps and floor of timber 12 × 12 ins. The piles were connected by vertical diagonal bracing.

The old bridge weighed about 128 tons, including the turntable, rollers, etc., and was transferred to a temporary pile pier and abutments to serve during the erection of the new bridge. The following particulars of this part of the work are taken from a paper by Mr. F. H. Bainbridge in the "Journal of the Western Society of Engineers," April, 1900:

> By means of scows, the bridge was lifted from its supports and floated to its temporary position. The operation of removal was, briefly, to fill the scows with water ballast and wedge up under the span; to pump water out of the scows until their buoyancy carried it clear of its supports, to move the floating bridge to its proper position, and lower to place by pumping water into the scows, at the same time allowing them to fill by removing plugs from their bottom.
>
> The pumps used in pumping out water ballast were one steam pump with 6 × 14-in. water cylinder; one steam pump with 8 × 14-in. water cylinder, running 80 revolutions per min.; two fire engines and two fire tugs, the

latter using steam siphons only. The fire tugs and engines belonged to the fire department of the city of Milwaukee. The total amount of water pumped out of the scows to lift the bridge clear of the center pier was 92,000 gallons, or 1,624 gals. per min. actual working time. The total amount pumped into the scows to lower the bridge was 6,400 gallons.

The time required to perform different parts of the work was as follows: The last train passed over the bridge at its permanent site at 9.05 a. m. Between 9.05 and 9.30 an ice jam was removed in the south channel in order to get the south scow under the bridge in its proper position; one fire tug and two scows, each with one fire engine, were placed in position west of the bridge, and one fire tug and two pile-driver scows east of the bridge. The boilers on the pile-driver scows furnished the steam for the steam pumps.

Up to 9.30 a. m. there was no interference with railway traffic over the bridge. At 9.30 all pumps were started, except on one fire tug, which was started at 9.35, and at 10.35 all water was clear out of the scows and the bridge stood 2 ft. clear of the center pier. It was believed to be essential that practically all water should be removed from the scows to prevent the sudden shifting of the water from listing the scows. At 10.45 the bridge started down the channel, being towed by the two pile-driver scows, one on each side the protection, the pile-driver scows being drawn by lines running ahead to the temporary protection, and the slack of the lines being taken up on the spools of the pile-driver engine. At 11.15 a. m. the bridge was over the temporary pier and abutments ready to be lowered. At 11.17, four plugs, each 3 ins. in diameter, from each scow, were pulled, and all pumps started to pump water into the scows to lower the bridge. At 12 (noon) the bridge was landed, and 12.10 p. m. the scows that supported the bridge in moving were released. At 12.20 p. m. the bridge was swung open by its own machinery to let the scows carrying the fire engines pass down the river, and at the same time the bridge was ready for traffic.

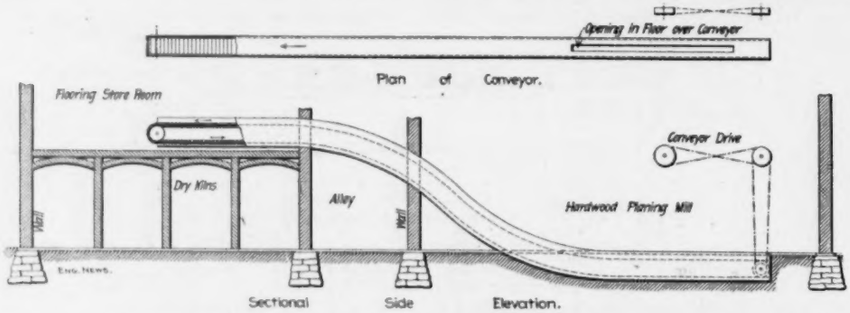

FIG. 1. PLAN AND ELEVATION OF CONVEYOR FOR FLOORING IN PLANING MILL OF JOHN SCHROEDER LUMBER CO., MILWAUKEE, WIS.
Chain Belt Co., Milwaukee, Wis., Builders.

CHAIN-BELT CONVEYORS FOR WOOD-WORKING PLANTS.

One of the notable features in most modern industrial plants is the use of mechanical conveyors for handling material to do the work more expeditiously than is possible with manual labor and to reduce the amount of this labor as much as possible. In the present article we describe two special forms of conveyors which have recently been installed in the planing mill of the John Schroeder Lumber Co., at Milwaukee, Wis. We are informed that the consulting engineer for this company estimates a saving of $15 to $20 per day over the old method of handling the material by manual labor.

The first of these is intended for carrying flooring from the hardwood planing mill across an alley and into the second floor of another building, where the flooring is stacked for storage. As shown by Fig. 1, the elevation is attained by long easy vertical curves of about 50 ft. radius, this arrangement being made necessary by the length of the flooring, which is about 16 ft. The total length of the conveyor is about 200 ft., and the difference in elevation of the ends is about 16 ft. The conveyor is of the apron type, and consists of two malleable iron chain belts, fitted with rollers, the links having wings, to which are attached maple boards or flights 24 ins. long, 4 ins. wide and 1½ ins. thick. These form a continuous traveling floor, which passes around pulleys at each end of the conveyor. Thicker flights are used at intervals to prevent the planks from slipping. The apparatus is enclosed in a wooden casing. In the floor of the planing mill there is an opening through which the finished flooring is dropped as it comes from the machine. At the delivery end two sorters and from three to five packers are required to handle the output and stack the flooring. The conveyor is driven by belting from a countershaft, and runs at a speed of about 100 ft. per minute. In ordinary service it delivers about 60,000 ft. of flooring per day.

The other conveyor plant is for handling kindling from two mills, and is of the "drag" type. There are two separate sets, one for the hardwood mill and the other for the pine mill, but only the former is shown in Fig. 2. Each set consists of two separate conveyors. All the edgings from the mill are cut up into kindling by a 16-saw slasher, A, the wood falling into a conveyor, B, which delivers it onto a second conveyor, C, running at right angles to the first. All butt ends and cull pieces of flooring are thrown into this second conveyor by means of hoppers in the floor, as shown. The conveyor carries the wood up almost vertically at the end of the building and through an opening in the wall, discharging it into a steel storage tank in the alley between the two mills. This tank is about 12 ft. diameter and 30 ft. high, divided by a partition to keep the two kinds of kindling separate. It has a hopper bottom, closed by trap doors. Wagons are driven into the alley and under the tank, and are loaded simply by opening the trap door in the bottom of the tank.

This conveyor is of a different style of construction from that shown in Fig. 1. It has a fixed floor of maple, and the chain belts carry maple flights 1½ × 6 × 24 ins., which are set on edge so as to sweep the wood along the trough of the conveyor. It runs at a speed of about 100 ft. per minute. Fig. 3 shows the construction of the two styles of conveyors. Fig. 4 shows the form of roller chain belt, which is one of the specialties of the Chain Belt Co. The upper view represents the chain used with the continuous traveling floor, the wooden flights being bolted to the wings of the chain. The lower view shows the construction of the chain without wings, and illustrates the means of interlocking the links so that the bolts or pintles are not subjected to undue strains. The links are of malleable iron, each formed of two side bars and a hollow crosspiece or pintle at one end. The pintle projects beyond the side bars, and the outer ends of these bars are formed with sockets of corresponding shape. When the chain is put together the projections on the end of one link fit into the sockets of the next link, so that the function of the pintle bolts is mainly to hold the bars laterally and not to transmit the pulling strain. These chains are made in a great variety of forms to suit various requirements. They are made by the Chain Belt Co., of Milwaukee, Wis., which also built the conveyor plant above described, and we are indebted to this company for plans and other information.

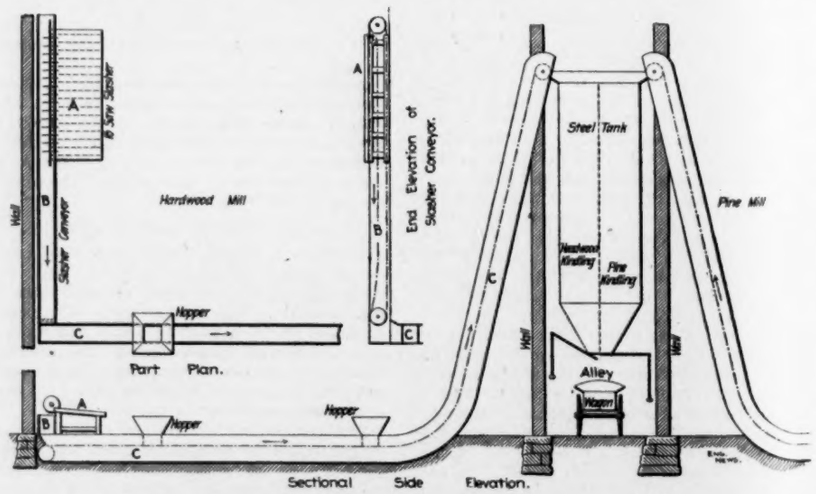

FIG. 2. CONVEYOR FOR KINDLING WOOD IN SCHROEDER MILL.

THE RELATION OF ARCHITECTS TO EXPERT ENGINEERS IN BUILDING CONSTRUCTION.

In our issue of Dec. 20 last we published a report of the annual convention of the American Institute of Architects at Washington, D. C. In that report the action of the Institute with respect to fees for expert services was briefly recorded, the standard schedule of fees being raised to 10% for heating and ventilation, sanitary, electrical and mechanical work.

In the official proceedings of this convention just published the report presented by the committee on this subject is given in full, and we reprint it, with parts of the discussion which preceded its adoption, as follows:

Your committee reports that in conference with a committee appointed by the American Association of Heating and Ventilating Engineers, and in consultation with sanitary, electrical, mechanical, and other experts, and with architects representing all sections of the country and all classes of practitioners, there has been practical unanimity of opinion on the following points:

(1) That in the design, construction, and equipment of modern buildings, the problems of sanitary, electrical, and mechanical engineering, of heating and ventilation, of structural work and foundations, are much more complicated, and their solution much more expensive, than was the case when the present schedule of charges of the Institute was first adopted, at which time, to use words taken from a recent convention report, "The erection of a building could safely be left to a competent carpenter's foreman or to a master mason." And this development has in many cases rendered necessary the employment of experts, either permanently on the staff of the architect or by engagement for a specific work.

(2) That the amount of labor and expense required from an architect now, even when the best of experts are en-

gaged, and independent of their fee, is greater than was contemplated when the present schedule was adopted, but is necessary for the molding of these parts into complete harmony with the architect's design in all classes of work.

(3) That the usual charge for efficient expert service is 5% of the cost of the special work involved where this amounts to $10,000, with a gradual increasing of the percentage as the amount diminishes from $10,000 down to $2,000.

(4) That the expense of expert service should be paid by the client as a necessary part of the cost of the work.

(5) That the architect should select the engineer or expert, whose work should be subordinate to that of the architect, and should be done under his directions, in hearty co-operation with him.

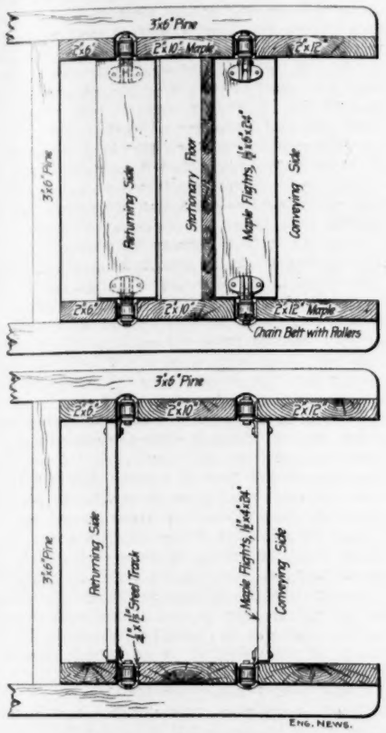

Fig. 3. Cross-Section Showing Construction of Conveyors.

(6) That the architect should assume all expense for expert services necessary for the proper execution of a work, and therefore that the schedule fee for heating and ventilation, sanitary, electrical, and mechanical work should be 10% on the cost of these parts.

We therefore recommend that the schedule of charges of the Institute be so amended that the minimum charge for professional services in connection with electrical, mechanical, and sanitary engineering, heating, and ventilating shall be 10% on the cost of these portions of the work, the architect to select or approve any experts required, and to assume all expense for their services, whether rendered by members of his personal staff or engaged for a specific work.

Respectfully submitted, A. J. Boyden, Chairman.

DISCUSSION.

Mr. Walter Cook.—The New York Chapter passed a resolution declaring the principle that the expenses of experts should be borne by the clients, in their opinion. This is in accordance with the findings of the committee.

Mr. Walter Cope.—I should like to ask whether the report means to recommend that the client, the owner, should pay the cost of expert services in the matter of what is commonly called "civil engineering." Our Chapter has discussed the question at great length. In my own practice I have simply drawn a line between statics and dynamics, and would be glad to know what the other members of the Institute do. Two kinds of civil engineering seem to me to come within an architect's duty. On general principles it is his duty to make his building stand up and to construct it scientifically. In the matter of electrical work and of heating, in which questions of electrical and mechanical engineering enter into the problem, I have always insisted that, just as the family physician tells his patient that an operation is necessary, and that a surgeon must be engaged, but does not go out himself and pay the surgeon to perform the operation, so I have always said that it is a proper thing for me to have, in addition to my own attention to this matter, the advice of an expert. As I understand the report of the committee, they would class that with questions of purely structural work. I would like to know precisely what the report means in that matter. It has always been my practice to include, as part of the work to be paid for by the client, chemical tests of materials, including tests of steel work, which does not seem to me to be a part of architecture. The testing of materials is certainly not a part of architecture, and, on the other hand, a knowledge of the strength of materials and their proper employment does not seem to me to be a part of architecture.

Mr. A. J. Boyden—I am glad to state that while we have spoken of the structural engineering and certain phases of ventilation work as being more expensive and complicated than they were formerly, we assume the general structural engineering to be a part of the architect's services, and have not included that in our recommendation for extra costs. I speak, for instance, of cases of difficult foundations, which would come within the province of the architect.

As a personal opinion, I will say I do not consider in a large and important enterprise, where there are extremely difficult foundations, that the architect would be wise to work without expert service, and I do not know but it should be paid for, in a case like that, as anything else, as in heating; but the general ordinary structural engineering, which comes in ordinary practice is, as I understand it, legitimately a part of the architect's services, and is not included in the recommendation.

Mr. Walter Cook.—It is felt to be of very great importance that the expert should be placed immediately under the direction of the architect. They felt that the expert should be, definitely, an employee of the architect and paid by him. I think any device by which the owner would be represented as employing two men would be much to be deplored.

Mr. Alfred Stone.—Many architects have work done by their own staff or employ an expert, and get the charges from the client, if they can get an extra charge; and if not, include it in the 5%.

A CODE FOR THE CONDUCT OF ARCHITECTURAL COMPETITIONS.

At the last annual convention of the American Institute of Architects, a new code to govern architectural competitions was adopted. While many architects object to competitions, it is recognized that the public often insists upon them and that in many cases they do serve a good purpose. The Institute formerly had a standard code, but it was suspended by the annual convention of 1899. The new code was framed by a committee consisting of Messrs. R. C. Sturgis, of Boston; R. W. Gibson, New York; F. M. Day, Philadelphia; H. L. Warren, Boston; and T. C. Young, St. Louis. We print it in full as follows:

FORM OF COMPETITION.

A competition as a means for the selection of an architect may properly assume one of the following forms:

(a) Limited to a certain number of architects, each of whom is invited to take part.

(b) Open to all who desire to enter or to all of a certain class.

(c) Mixed, certain architects being invited, but others being at liberty to take part.

PAYMENT OF COMPETITORS.

In all competitions the first prize should be the award of the commission to design the building and superintend its construction, and the programme should definitely state that the successful competitor will be so retained, and that he will be paid for his services at the rates established by the American Institute of Architects.

In certain cases, however, this procedure may not be legal; then the course to be pursued as to the successful competitor should be clearly stated.

To provide for the contingency of delay or of the discontinuance of the work, the programme should provide for a substantial payment to the successful competitor on the award of the competition, such payment to be regarded as on account of the final commissions.

Payments to unsuccessful competitors should be as follows:

In limited competitions each should be paid a fixed amount.

In open competitions prizes fixed in number and amount should be provided.

In mixed competitions the two classes of competitors should be paid in the manner above described.

THE PROFESSIONAL ADVISER AND THE JURY.

It is highly desirable, in the interests of both owner and competitors, that a professional adviser should assist in the preparation of the programme and that the professional adviser or a competent jury, consisting at least in part of experts, should assist in making the awards.

The professional adviser or jury may have full power to make the award, or they may select a number of designs and, placing them in the order of merit, leave the final choice to the owner or his representatives.

Where possible, the adviser or the jury should make a positive report in favor of one design and recommend the employment of its author as architect for the building.

THE PROGRAMME.

The programme should be so drawn as to form a contract. It should:

(a) Name the owner of the structure forming the subject of the competition, and state whether the owner institutes the competition personally or through representatives. If the latter, name the representatives, state how their authority is derived, and define its scope.

(b) State the kind of competition to be instituted, and, in limited competitions, name the competitors; or, in open competitions, if the competition is limited geographically or otherwise, state the limits.

(c) Fix a definite time and place for the receipt of the designs. The time should not be altered except with the unanimous consent of the competitors.

(d) State the limit of cost, if fixed; the desired accommodation, and the conditions of the site.

(e) Fix uniform requirements for the drawings, giving the number, the scale or scales, and the method of rendering. As the presentation of a general scheme (rather than of a design perfectly studied in all its parts) is the object of the drawings, they should be of the simplest kind capable of explaining such a scheme.

(f) State whether the submission of more than one design by a competitor is forbidden or permitted.

(g) State whether the competition is to be anonymously conducted or not, and if anonymously, provide the method.

(h) Name the judge or jury or provide a method for their selection. Define his or their power.

(i) Provide for the placing out of competition of any drawing which violates the terms, or of any set of drawings whose authors have so disregarded the terms as to deserve the extreme penalty.

(j) Provide that during the competition there shall be no communication upon anything relating to the competition, except in writing, between any competitor on the one hand and the owner, or any representative of the owner, the professional adviser or any juror on the other, and that any information, whether in answer to such communication or not, shall be given in writing simultaneously to all competitors. Set a date after which no question will be answered.

(k) Fix the nature or amount of the awards or prizes.

(l) State, in case the professional adviser or jury is not empowered to make the award, in whom such power is vested.

(m) Fix the period of time within which the final decision will be rendered.

(n) Provide for sending the decision and a copy of the report to the professional adviser or of the jury to each competitor.

(o) Provide that no drawing shall be exhibited or made public until after the award, and not then without the consent of the author.

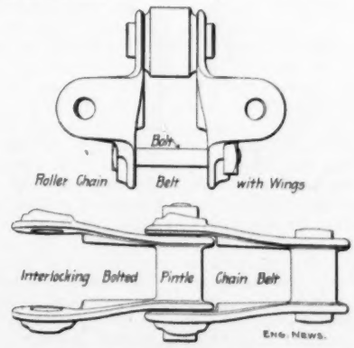

Fig. 4. Chain Belts for Conveyors (With or Without Rollers).

(p) Provide for the return of unsuccessful drawings to their respective authors within a reasonable time.

(q) Provide that nothing original as to this competition in unsuccessful designs shall be used without compensation to the author of the design in which it appears.

THE RAPID TRANSIT TUNNEL in New York city is progressing faster than had been expected. The excavation is about one-quarter completed and the payments already made to Mr. John B. McDonald, the head contractor, amount to $7,319,000. In spite of the intense heat the largest month's work was done in July. At the present rate of progress the tunnel itself will be finished in the Spring of 1903.

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The agitation for the better ventilation of the tunnel road by which the trains of the New York Central & Hudson River R. R. and its allied lines enter New York city has within the last few days brought out a report advocating ventilation from Mr. Albert A. Cary, M. Am. Soc. M. E., the expert employed by the District Attorney to investigate the problem, and also a presentment by the Grand Jury recommending the adoption of other motive power than steam for handling the entire tunnel traffic. The report of the District Attorney's expert is briefly summarized in another column of this issue. As will be seen, it advocates the installation of some 40 ventilating fans, each discharging through a steel chimney or shaft, 100 ft. high, at intervals of about 250 ft. along the portion of Park Ave. under which the tunnel runs. There is no good reason, as we stated in our issue of July 11, why a ventilating system of this general character should not work satisfactorily and keep the atmosphere of the tunnel in a reasonably pure and comfortable condition. As designed, however, the system proposed by the District Attorney's expert is open to the strong objection that, in the long row of discharge stacks a construction is introduced which can hardly fail to be unsightly. Indeed, we are much mistaken if the residents of Park Ave. do not object, and very justly object, to a construction of this sort in even more vigorous terms than they now complain of the foul gases which invade their homes from the surface openings of the tunnel. We will not discuss here how this objection may be overcome, but that it can be overcome we have no doubt, although to do so will quite certainly add largely to the cost of the work.

The recommendations of the Grand Jury for the abatement of the existing evils of the tunnel are, in brief, as follows:

1. That the brick walls dividing the tunnel be promptly removed, and that steel columns and girders be substituted therefor.
2. That passenger coaches while not in use during the day be protected from the sun by a shed; and,
3. We further recommend that, inasmuch as the most eminent engineers assert that there is no remedy for these existing evils so long as coal-burning locomotives are in use, the railroad companies be compelled by and under such laws as may be provided for that purpose to change forthwith the motive power within the tunnel and its approaches to some method of propulsion as will not, as heretofore stated, endanger the public comfort and health.

It is with the last of these recommendations, we imagine, that engineers will be chiefly concerned. As we stated in our issue of July 11, it would be of interest to engineers to know the names of the "most eminent engineers" who assert that there is no remedy for existing conditions as long as coal-burning locomotives are employed. The fact of the matter is, of course, that the claim that this tunnel cannot be thoroughly ventilated, if competent engineers are given fair limits as to expense and methods, is the most utter nonsense. The off-hand manner in which the recommendation is made that the railways using the tunnel "change forthwith" the motive power of the 500 or more trains which pass through it daily would be more satisfactory to the railway officials and to engineers generally if it conveyed some hint as to how this task was to be accomplished. We risk nothing in saying that a very great number of prominent engineers are not at all agreed as to how it can be accomplished. If electric motive power be adopted, and it may be mentioned in passing, that no other form of motive power has been developed which is worth consideration in comparison, there are several characteristic and very serious problems to be solved, as we pointed out in our previous discussion. We shall not enter further into the discussion of these problems here; all that we desire to point out is that the much-paraded investigation by the Grand Jury has not offered a single suggestion which is of any practical value toward the bettering of what has come to be regarded as a very serious public nuisance.

The garbage disposal litigation in New York, noted elsewhere in this issue, may raise some ugly questions. The board of estimate and apportionment seems to have been temporarily staggered by the increase in price ($90,000 to $232,000) called for by the lowest bidder and old contractor, and also by the use which Mr. Eugene McClean, Engineer to the finance department under Controller Coler, made of the figures submitted by Mr. W. F. Morse. We have made no attempt to verify Mr. Morse's figures of the prices paid for garbage disposal by other cities, nor of the profits which he alleged the company would make under the new contract. Neither have we tried to check the figures in rebuttal which we understand that Mr. Macdonough Craven compiled for Mr. P. E. Nagle, Street Cleaning Commissioner. In fact, it is questionable whether anything short of a court of law and expert witnesses could put figures for cost of garbage disposal service in other cities on anything like a comparative basis. But supposing it was done, would that explain the failure of the street cleaning department to delay advertising for bids until all possibility of real competition was dead? Or the strange reversal of its own vote made by the board of estimate and apportionment after a lapse of a few weeks? Philadelphia pursues very similar tactics year after year, and the contract goes regularly to one and the same contractor. True, that contractor was underbid last December, and the award was made to the lower bidder, but the latter abandoned the job inside of a week and the old contractor resumed operations. At St. Louis, a ten-year contract expires soon, and a hard fight has been necessary to get an ordinance forward in the city council providing for a new letting more than a few weeks in advance of the expiration of the contract. The latest reports at hand indicate that the St. Louis ordinance will be passed at once, and that the new contract will be cut down to three years, with provision for purchase by the city at a price to be fixed by arbitration. The most prompt action will be none too speedy if any competition is to be secured. Why is it that the expiration of a garbage disposal contract in most of our large cities is almost sure to be accompanied with scandal, if not with litigation? Two causes are more potent than all the others combined: (1) Short term contracts, which cannot be entered upon de novo without enormous risk by any contractor who has no political pull to assure a renewal of the contract by hook or by crook; and (2) the failure of municipal authorities to secure and follow the best engineering advice when dealing with garbage problems.

NATIONAL AID FOR IRRIGATION.

In our issue of June 27 we called attention to the probability that National aid for irrigation works will be one of the most important questions before the next Congress, and noted the drafting of a bill for presentation in the next Congress by a conference of those interested in irrigation work held at Cheyenne, Wyo., on June 20.

Our editorial comment has called out two interesting replies, one from Mr. Fred. Bond, State Engineer of Wyoming, and the author of the bill which was considered at Cheyenne, and the other from the Executive Chairman of the National Irrigation Association, an organization whose principal object it is to agitate for the construction of irrigation works by the National Government.

Mr. Bond in his letter presents the full text of the bill drafted at the Cheyenne conference. Its purport is in brief to give to each arid state the moneys received from the sale of United States lands within its borders, provided it will use such moneys for the construction of reservoirs and other irrigation works.

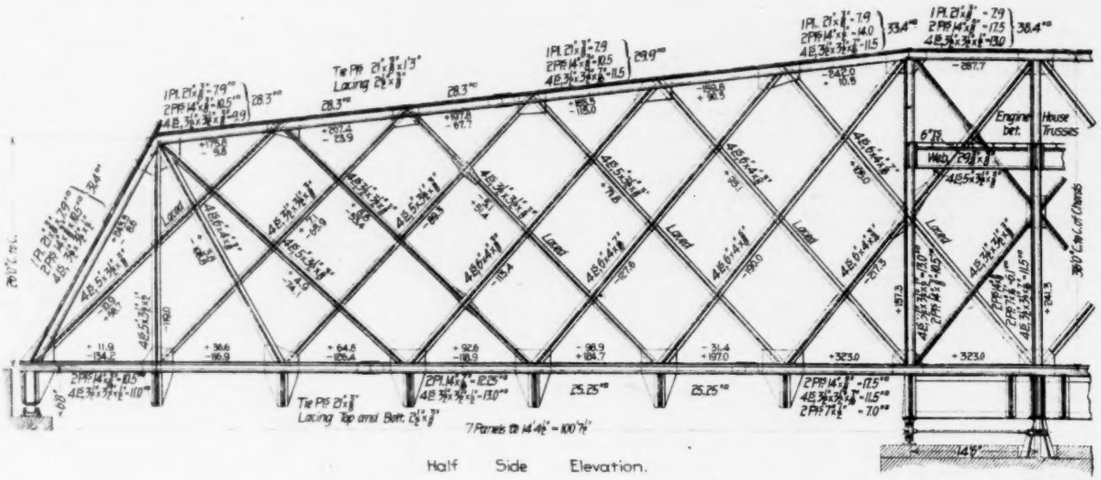
In commenting upon this bill on June 27 we suggested that the division of responsibility between State and National officials which the bill contemplated would lead to friction and bad work. This comment was based, as Mr. Bond surmises, on meager and misleading press dispatches concerning the contents of the bill. On examination of the complete bill we find no such division of responsibility as was reported. The responsibility is placed upon the State officials, and the Secretary of the Interior is given only such powers, for the approval or rejection of specific enterprises, as are needful to checkmate improper schemes.

In the second letter, by Mr. Maxwell, of the National Irrigation Association, the general policy of the Cheyenne bill is attacked. Mr. Maxwell is diametrically opposed to placing the arid lands and the works for their reclamation under state control. He insists that the National Government must do the whole thing. He urges that the scheme to turn the lands over to the states is brought forward by the state engineers to increase their own importance and responsibility. A second and much more serious charge which he makes is that back of the movement to place these lands under state control are the wealthy stockmen and ranchmen of the West, which desire to control irrigation development for the purpose of excluding actual settlers.

We have examined with considerable care the Cheyenne bill, and we fail to find any internal evidence therein that either of the objections raised by Mr. Maxwell actually exists. As we read the text of the Cheyenne bill, it appears to have been drawn in good faith to carry out the construction of irrigation works and cause them to be so planned and controlled as to provide for the greatest benefit to the greatest number.

Nobody will question, we presume, that if irrigation works are constructed by either National or state action, the lands reclaimed should go to small farmers and homesteaders and should not be suffered to fall into the hands of land speculators or wealthy corporations. Mr. Maxwell assumes that National control instead of state control of the work will effect this; but he gives no reasons in support of this assumption. Of course politics in some of the far Western states are notoriously corrupt; but the same influences which are dominant in these states control the selection of their Senators and Representatives in Congress, who will control Congressional action with respect to irrigation matters and will be largely influential in whatever work the National Government may undertake.

You cannot purify a muddy stream by merely diverting it from one channel to another. If



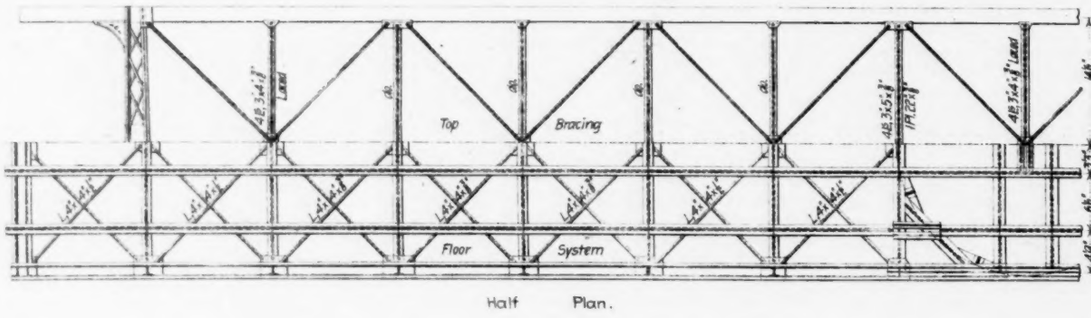


FIG.4. DETAILS OF SUPERSTRUCTURE.

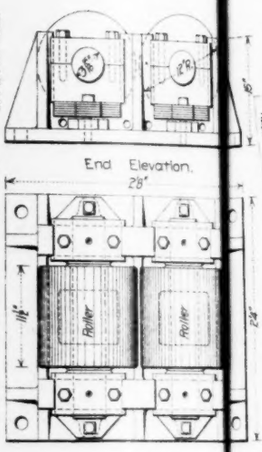
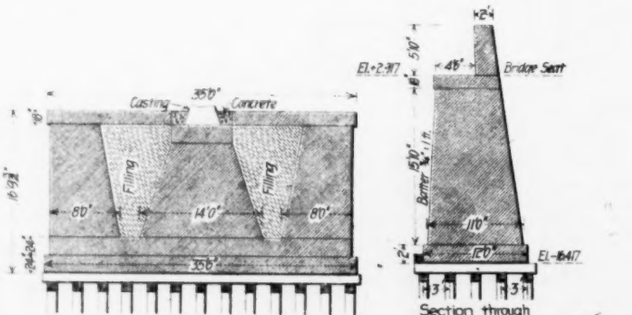


FIG.9. END BEARING



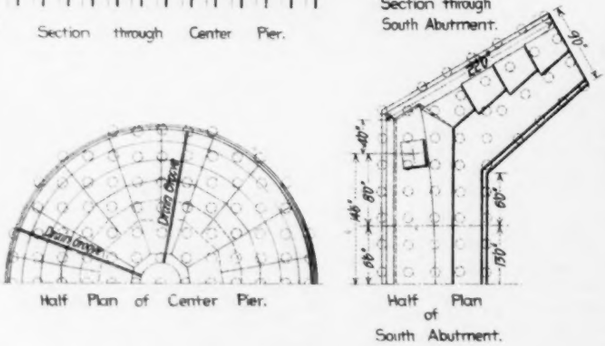


FIG. 2. CENTER PIER AND ABUTMENT.

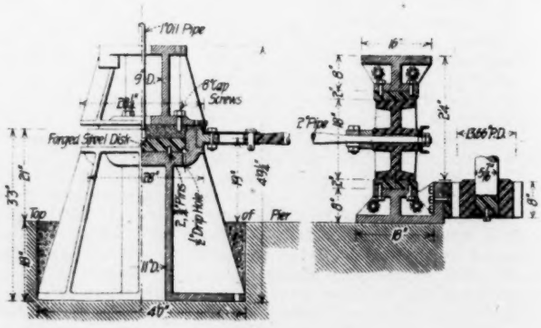


FIG. 8.
CENTER BEARING AND ROLLER RING.

THE KINNICKINNIC RIVER DRAWBRIDGE; CHI

E. C. Carter, Chief Engineer. W. H. Fin
F. H. Bainbridge, Bridg

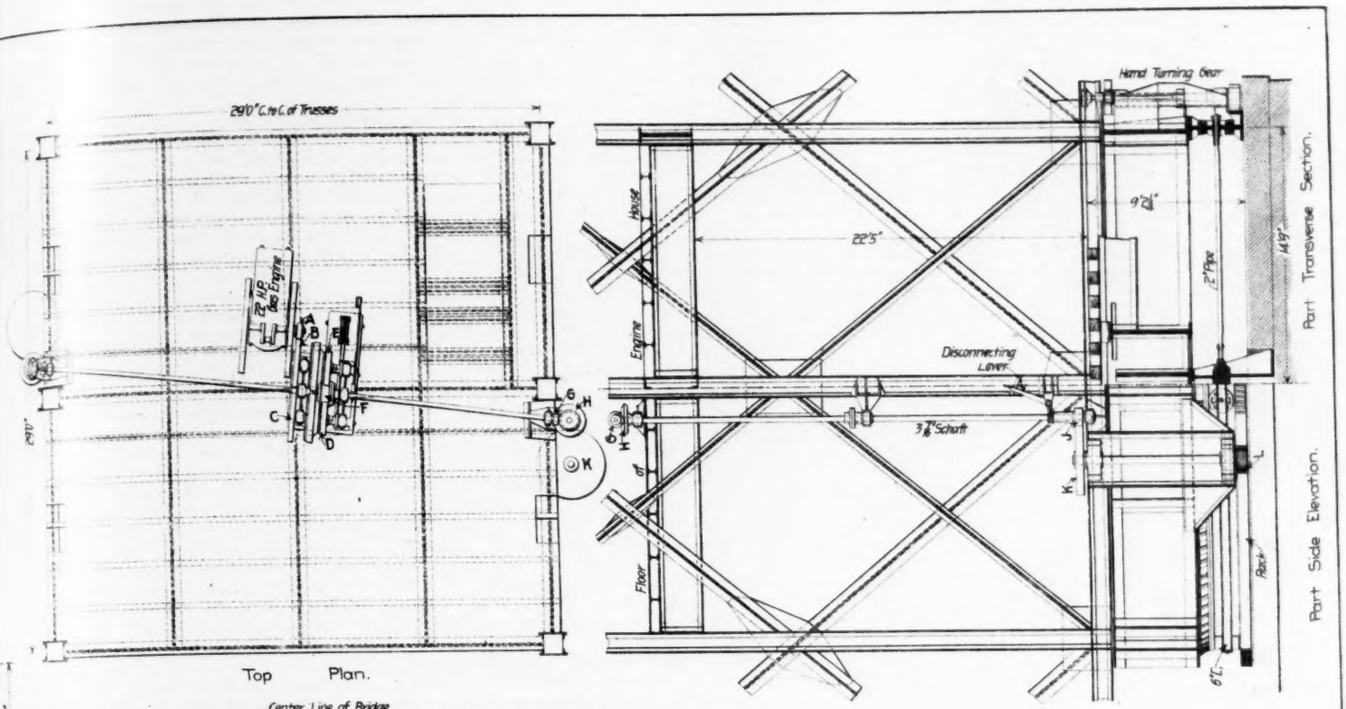
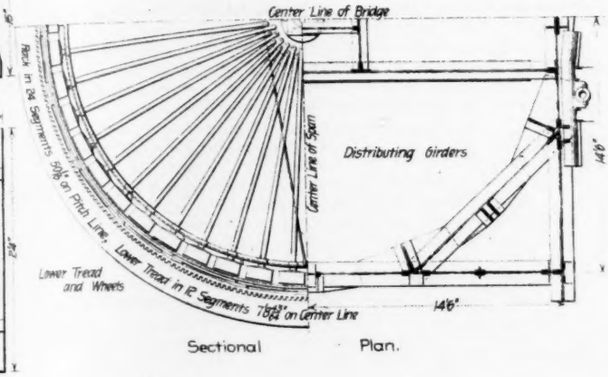


FIG. 6. GENERAL ARRANGEMENT OF MACHINERY.



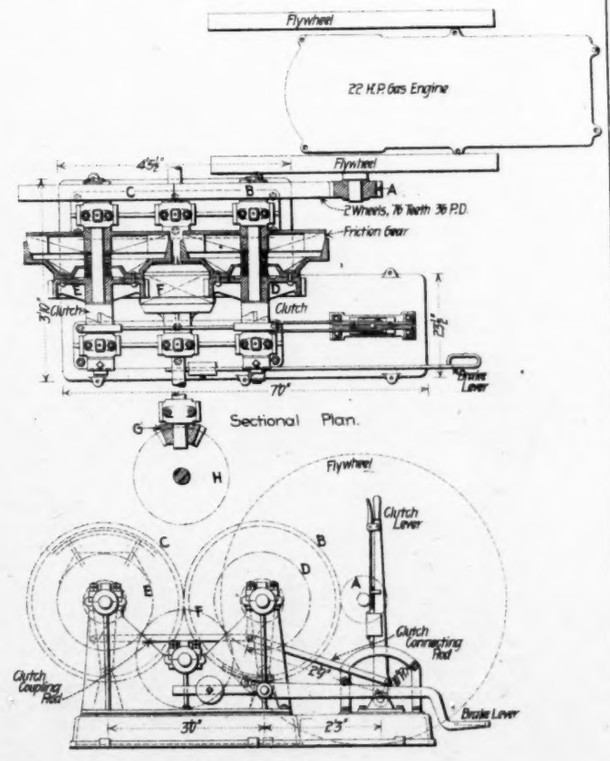


FIG. 7. MAIN TRAIN OF GEARING FOR OPERATING BRIDGE.

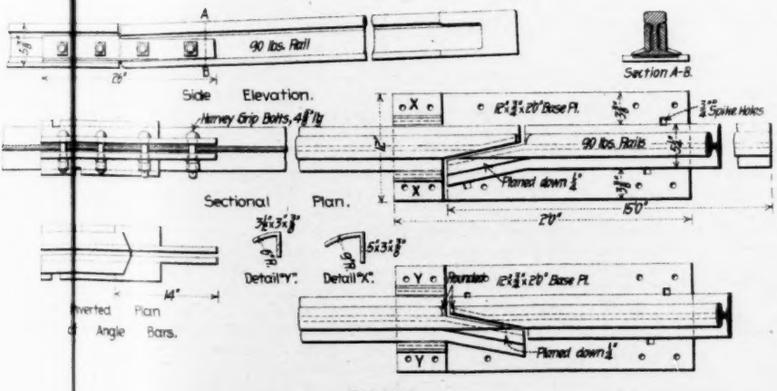


FIG. 10.
RAIL JOINT
AT ENDS OF DRAWBRIDGE.

BRIDGE; CHICAGO & NORTHWESTERN RAILWAY.

W. H. Finley, Principal Assistant Engineer.
ainbridge, Bridge Engineer.

CHAS. HART, LITH., 59 VESEY ST., N. Y.

Montana stock interests control the politics of the State, they will have a large voice also, we may be sure, in whatever action the Federal Government may take with respect to Montana public lands.

The question of the relative jurisdiction of State and Federal governments is a large one, of course; but there are very sound and weighty reasons for leaving local matters to the control of the individual states just as far as possible. In irrigation matters, for example, each state has its own system of land laws and water laws, and its own courts and machinery for their enforcement. These will have to govern the settlers upon any works the National Government may undertake. Should Congress attempt to override this and create a special system of laws to govern settlers upon National irrigation works, the chances are that in its ignorance of local conditions it would do no better than the state legislatures have done, and very likely not so well.

The fact is that the real underlying reason for the demand for National action respecting irrigation is that the Federal Treasury is expected to furnish the money. The bill drafted at Cheyenne asks very modestly for nothing but the revenue from public land sales. The National Irrigation Association looks for nothing less than direct appropriations from the National treasury on a scale equal to those in the River and Harbor bill.

It is extremely likely, as we have before remarked, that in some form or other the desired aid will be granted; the practical question is how may be it so given as to accomplish the largest measure of benefit with the minimum of unwise and extravagant expenditure.

An argument often heard against National aid to irrigation is that the profitable sites for irrigation works have already been utilized by private enterprise and that the Government is now asked to step in and improve sites where the benefit to be derived will not justify the expenditure. Were this a fair statement of the case, no consistent defence of national expenditure on irrigation works could be made; but it is not a fair statement. Private investment in irrigation enterprise is hampered in many ways, most of all probably by inadequate legislation and by the litigation which has grown out of it. Private capital invested in irrigation works demands a high rate of interest because of the risks involved and because of the bad reputation which fraud and financial mismanagement has given to irrigation securities in general. The Government's funds on the other hand represent an interest rate of some 2%. At such a rate many reservoirs can be built and prove profitable which would be impossible as private enterprises.

It is not urged, therefore, that the Government should spend its money on unprofitable works. On the contrary, no works whatever should receive the aid of the National treasury unless they will be of such benefit to the land effected as to make them show a net profit.

Neither is it urged that the Government should undertake the work merely because it can command capital at a far lower rate than private enterprise. The Government is the owner of a large proportion of the lands which irrigation works will reclaim and render valuable, and these lands are subject neither to taxation nor assessment for benefits. Without irrigation these lands are worthless. With irrigation they can be made extremely valuable. Neither private enterprise nor the states themselves can carry out the necessary work in the construction of reservoirs to reclaim these lands, not only because of inability to command cheap capital, but because the lands to be benefited cannot be controlled in such a manner that each tract shall pay for the work in proportion to the benefit received and because the owner of the great bulk of the lands will take no part in their improvement.

It will be seen, therefore, that the claim for National aid to irrigation rests on far stronger grounds than mere substitution of public for private enterprise. The people of the West are not asking the Government to do something which might be done instead by the state or by private enterprise. They have already built irrigation works sufficient to utilize nearly the whole natural flow of the streams in the arid region during the irrigation season. Furtner progress in irrigation can only come through the storage of flood waters in reservoirs; and nearly the whole of this work is absolutely impossible without Government aid.

From the investigations made by the U. S. Geological Survey it is estimated that by a proper system of reservoir construction upon the rivers of the arid region from 74,000,000 to 100,000,000 acres out of the 600,000,000 acres of arid lands in the United States can be reclaimed and made available for agriculture. Remembering the great productiveness of irrigated lands, and that farming with irrigation is almost always intensive farming, the estimate that these reclaimed lands will provide food and homes for a population of 50,000,000 people does not seem so extravagant.

In comparison with such a possible development, every other project or public work which the Government is asked to undertake seems indeed insignificant. Where else on the globe, unless it be on the irrigation works of India, has there been an opportunity for public enterprise to provide homes for millions of families in a region once a barren desert?

Of course the process of reclamation ought to be and will inevitably be a gradual one. The complete work may well occupy not a decade, but the better part of a century. A beginning should be made on the reservoir sites which promise the largest and most speedy returns, and as these tracts are filled with settlers and lands in their vicinity grow more valuable, other sites will in their turn be brought within the field of commercial practicability.

Finally, while for other expenditures on public works, the United States receives no direct return, there is no reason why in its expenditure on irrigation works the Government should not in the long run receive back all it invests. What will be the value of these 75,000,000 acres of irrigated lands when reclaimed and made available for agriculture? The most moderate estimate shows an amount far beyond any possible cost of the entire system of reservoirs and other works necessary for their reclamation. Surely it is within the resources of statesmanship to provide that the nation shall eventually receive back the moneys which it devotes to this great work and that the remaining increment of value shall fall so far as possible to those who till the land and find homes upon it, and not to the land speculator or the water monopolist.

LETTERS TO THE EDITOR.

The First Steel Bridge in America.

Sir: In your paper for July 25, in the discussion upon the Chicago & Alton bridge over the Missouri River, completed in April, 1879, I notice Gen. Wm. Sooy Smith's statement that this "was the first great steel bridge that was ever built," and I cannot help recalling the fact that the Eads bridge at St. Louis, of which the arches or main carrying members are of steel, was designed in 1868 and completed in June, 1874. Though steel was not used for every part of the structure, I think the Eads bridge is fairly entitled to rank, in America at least, as the pioneer steel bridge. Very truly yours, Robt. Moore.

St. Louis, Mo., July 29, 1901.

A New Stadia Note-Book.

Sir: In your issue of Aug. 1 I am glad to notice that you propose to publish a stadia note-book with alternate pages arranged for field sketches to approximate scale. If suggestions are still in order, the two valid objections made to your sketch-page: (1) That the stadia station must always have the same position on the page; and, (2) That the circular and radial rulings confuse the drawing—can be overcome in a less expensive book made up of pages all ruled alike for the field notes and reductions, interleaved with two sheets of tracing paper, and provided (in a pocket in the cover) with a cardboard semi-circular protractor having the circular and radial rulings. In the field, this protractor is placed between the two leaves of tracing paper so that its rulings show through on the page opposite the notes, with its center in any position, and is kept in place by a rubber band or paper clip until the sketch or sketches are finished, when the rulings disappear with its removal. The binding in the front of a few blank pages and a stadia reduction table printed on one side of a folded insert leaf so as to show completely outside of the note pages when the book is open, would be an additional convenience.

Yours truly, L. F. Rondinella.

Philadelphia, Pa., Aug. 1, 1901.

A Rational Formula for the Length of Wasteways.

Sir: The following note will find its appropriate place in a later edition of my book on "Water Power." It is offered for advance publication: 1. Quoniam vita ipsa qua fruimur brevis est; and, 2. To give opportunity for criticism on the part of those so disposed:

On a given stream suppose that there is a dam commanding a drainage area of A square miles, with a length l of overflow. Suppose that the dam has stood for 50 years and that the water has never risen more than h feet on the crest. What length l_1 should a second dam have on the same stream or a stream subject to similar climatic influences, with the same limitation of depth. We suppose both dams to be so high that they will not be "drowned" by the down-stream level rising above the crest. At least we suppose them to be similarly situated in this respect.

The second dam bears precisely the same relation to its drainage area that the first does to its own. The lines of these two dams are homologous dimensions of their respective drainage areas. The areas themselves are substantially similar figures. What follows? Similar figures are to each other as the squares of their homologous dimensions. Homologous dimensions of similar areas are to each other as the square roots of the areas. If A_1 be the area appertinent to the second dam, and l_1 its length of overflow,

$$l_1 = l\sqrt{\frac{A_1}{A}}.$$

This assumes the same maximum depth on both dams. If the depth on the second dam is limited to h_1, then l_1 must be such as will make good the discharge. The discharge per unit length of the second is to that of the first as $h_1^{\frac{3}{2}}$ to $h^{\frac{3}{2}}$, we must have therefore

$$l_1 = l\sqrt{\frac{A_1}{A}}\left[\frac{h}{h_1}\right]^{\frac{3}{2}}$$

l and h are usually expressed in feet, and A in square miles, but this does not alter the value of the expression for l_1, since

$$l\sqrt{\frac{(5{,}280)^2\,A_1}{(5{,}280)^2\,A}} = l\sqrt{\frac{A_1}{A}}.$$

As an example, consider the Connecticut River. The dam at Holyoke has stood for more than 50 years with l = 1,017, and no value of h exceeding 12 ft. A here = 8,006 sq. miles. What should be the value of l_1 at McIndoe's Falls, where A_1 = 2,173?

$$l_1 = 1{,}017\sqrt{\frac{2{,}173}{8{,}006}} = 530.$$

The dam of the Connecticut Valley Lumber Co. at this point has an overflow rather in excess of this figure.

At Lunenburg, where A_1 = about 1,500,

$$l_1 = 1{,}017\sqrt{\frac{1{,}500}{8{,}006}} = 440.$$

The length adopted here by the Dalton Paper Co. is 321 ft. and appears inadequate. A disastrous washout has occurred here, but it cannot with certainty be ascribed to the inadequate wasteway.

If 1,017 is the proper length at Holyoke, what should be the length of spillway at Lawrence, where A_1 = 4,600, limiting h_1 to 10.5 ft.

$$l_1 = 1{,}017\sqrt{\frac{4{,}600}{8{,}006}} \times \left[\frac{12}{10.5}\right]^{\frac{3}{2}} = 942.$$

The length of spillway appertinent to the Lawrence dam is 900 ft., and it is understood that the depth thereon has never much exceeded 10 ft.

Again, if 900 ft. for the Lawrence dam be sufficient to limit h to 10.5, what should be the length for the dam built not long ago at Sewalls Falls, N.H., when A_1 = 2,350 with the same limitation of h_1

$$l_1 = \sqrt{\frac{2{,}350}{4{,}600}} \times 900 = 643.$$

The length actually adopted here was 497 ft. This dam has suffered much damage in high water, but it is probable that it is "drowned" to some extent at such times. The value of h_1 has reached 14 ft.

If 1,017 ft. is a proper length for the Holyoke dam, with h limited to 12, what would have been a proper length for the wasteway appertinent to the South Fork dam near Johnstown, Pa., which failed in 1889, where h_1 was limited to 10. A_1 being 48.6 sq. miles.

$$l_1 = 1{,}017\sqrt{\frac{48.6}{8{,}006}} \times \left[\frac{12}{10}\right]^{\frac{3}{2}} = 104 \text{ ft.}$$

Such a wasteway would have saved the dam, and would have had but little capacity to spare.

Usually in the case of a reservoir, the accumulation of water in the reservoir while rising on the wasteway, is an element of safety to the dam, as it may delay the time of high water till its maximum flow is past, but when the stream continues for some hours at its maximum flow, the overflow of the earthworks is delayed, but not prevented.

If l = 1,017 be a sufficient length at Holyoke to restrict the flood height to 12 ft., what would be the value of l_1 on

a dam commanding 50 sq. miles, where h_1 cannot exceed 5 ft.?

$$l_1 = 1{,}017 \sqrt{\frac{50}{8{,}006}} \left[\frac{12}{5}\right]^{\frac{3}{2}} = 299 \text{ ft.}$$

Such a length of wasteway looks enormous to the practical man, and it is for this reason that storage reservoirs are seldom built with sufficient wasteways.

If $l = 900$ is a sufficient length for the Lawrence dam to restrain h to 10.5 ft., how high might the water be expected to rise on the dam of the Jackson Mfg. Co., at Nashua, N. H., which has a spillway 134 ft. long, a commands a drainage area of 524 sq. miles?

$$134 = 900 \sqrt{\frac{524}{4{,}600}} \times \left[\frac{10.5}{h_1}\right]^{\frac{3}{2}};$$

$$h_1^{\frac{3}{2}} = \frac{900}{134} \sqrt{\frac{524}{4{,}600}} \times (10.5)^{\frac{3}{2}} \quad \therefore h_1 = 18.12.$$

The length of this spillway should have been, according to the above principles for $h_1 = 10.5$.

$$l_1 = 900 \sqrt{\frac{524}{4{,}600}} = 304 \text{ ft.}$$

Flood height on this dam will in future be much modified by the great reservoir of the Metropolitan Water Board at Clinton. The fact remains, however, that it is a remarkably narrow wasteway.

It must be remembered that the above computation of the value of h_1 assumes what is not true, viz.: that the abutments of the wasteway rise indefinitely. The computed height could never be reached because the water would overflow the abutments and spread to a greater seldom built with sufficient wasteways.

In striking contrast with the Jackson company's wasteway at Nashua, is the wasteway adopted for the Wachusett Reservoir now in course of construction for the Metropolitan water-works at Clinton, on the same stream, where the drainage area is 118.23 sq. miles.

Here we find a wasteway proposed 450 ft. in length with its crest 20 ft. below the top of the dam. That is to say: This wasteway has a length equal to half that of the Essex company's dam at Lawrence, which commands a drainage area of 4,600 sq. miles, and provides for a depth nearly twice as great as was ever observed on that structure.

Though the dam itself rises 20 ft. above the wasteway, it can hardly be supposed that the designers contemplated a rise of water to that level, as a rise of 15 ft. above the crest of the wasteway would overflow embankments. If the water should rise to the latter limit, the wasteway would be discharging seven-eighths as much as has gone over the Lawrence dam during the last 50 years, and, since the surface of the full reservoir is 6.5 sq. miles, the volume accumulated during the progress of the flood would be equivalent to more than 9 ins. in depth over the entire drainage area. It will hardly be denied that the engineers of this work have made a sufficient provision for the escape of flood waters.

According to our rule, a wasteway

$$900 \sqrt{\frac{118.23}{4{,}600}} = 144 \text{ ft. in length}$$

at the Wachusett dam would never have a greater depth on it than is liable to occur on the Lawrence dam.

Jos. P. Frizell.

60 Congress St., Boston, Mass., July 2, 1901.

The Accident to the Brooklyn Bridge.

Sir: The recent breakage of a number of suspender rods on the Brooklyn Bridge, which temporarily interrupted the travel on the north roadway of the bridge, has caused some inconvenience to the public and also considerable alarm about the general safety of the structure. The daily papers were filled with comments on the subject, some of an unnecessarily exaggerated and sensational character, and different bridge experts published reports of their investigations and of what they considered the cause of the occurrence. These investigations could naturally be only superficial, and the conclusions derived therefrom should be accepted with caution. The bridge engineers themselves assured the public that there was no danger, and that the bridge, after the damage was repaired, would be as strong as ever; but the general feeling of the public, even among professionals unfamiliar with the construction of this bridge, seems still to be inclined to believe that this accident to the suspenders is an indication of the general weakness and unsafety of the whole structure. I believe, therefore, that an explanation of the accident, as well as a few words about the strength and construction of the Brooklyn Bridge, will be of interest to the readers of the Engineering News. Being familiar with the details of the Brooklyn Bridge—in fact, as assistant to Col. Roebling, having made the calculations and plans of the whole superstructure—I may hope that the facts and figures I present will be accepted as correct, and will reassure the public in regard to the safety of the bridge.

The breaking of suspenders has not been an infrequent occurrence on smaller suspension bridges without causing an accident, but if, as at the Brooklyn Bridge, nine successive suspenders break at the same time, the matter looks more serious; and I believe the Superintendent of the bridge acted wisely in closing the roadway for heavy vehicles until at least two or three of the rods had been replaced. Of course, there was no danger of the floor falling into the river, because the stiffening trusses and the cantilever qualities of the floor beams are sufficient for sustaining the whole dead weight for at least 250 ft. and for transferring the same to the suspenders beyond, but it was advisable to avoid an overstrain in other parts of the bridge and an undue distortion of the floor system.

The direct cause of the breaking of the rods cannot be told with absolute exactness. There is no testimony that an unusually heavy wagon or trolley car was crossing the bridge and could have overloaded the suspenders, nor was the heat on that day enough greater than on former days to cause a greater expansion of the metal than had happened before. There was also no weakness or fault in the original construction of the respective details, as one of the experts acting for the New York "Journal" claimed to be the case, asserting, as quoted by the "Journal," that the calculations of temperature stresses in suspension bridges were unknown at the time the bridge was designed. I take this opportunity to say that this gentleman is mistaken; the engineers of the Brooklyn Bridge were as well acquainted with the temperature stresses at that time as bridge experts are to-day, and the effects of temperature changes were fully taken into account and provided for when the details of the bridge were dimensioned. The fact that these suspenders were in service for 18 years without showing signs of weakness is a proof that they were strong enough for all stresses allotted to them in the design, and the further fact that, together with the rods, two cable bands and several trunnion plates broke, is a proof that these parts were subjected to exceptional stresses, but that they were well proportioned.

There was, of course, some cause for the breaking of the rods, and in order to understand better the different theories that can be advanced for explaining that cause, I will give a short description of the construction of the superstructure. The floor beams consist of triangular lattice girders, 86 ft. long by 2 ft. 8 ins. high, each beam being suspended at four points to the cables and forming a continuous girder over three openings of 35 ft., 13 ft. and 35 ft. length, respectively. There are six stiffening trusses, two near the inner cables, 18 ft. high, two between the inner and outer cables, also 18 ft. high, and two near the outer cables, 10 ft. high. The trusses and floor beams are rigidly riveted together, hence the rupture of one or several suspenders is absolutely of no consequence. In fact, every suspender of the outer cables might break for a distance of 250 to 300 ft. without doing any appreciable damage to the bridge. The two middle trusses alone are sufficient for transferring the whole dead weight of 300 ft. length to the suspenders beyond. The inner cable suspenders would have to carry twice their usual load, which they are fully able to do, and the floor beams, in their capacity as cantilever arms of 20 ft. length, could sustain all the dead weight of the floor and a good deal of live load in addition. The weight resting on one floor beam for a length of 20 ft. is about 5,400 lbs.; the top and bottom chord sections are about 10 and 29 ins., hence the maximum fiber stress is only about 2,000 lbs. per sq. inch. This indicates that every floor beam unsupported by an outer suspender or an outer truss could, in addition to the dead weight, safely carry a live load of at least 12 tons uniformly distributed over the cantilever arms. These figures show that the alarm which the recent accident to the suspenders created among the public was unfounded, and that no danger need to be apprehended, even if 20 or 25 successive suspenders should break at once.

The floor beams are placed 7½ ft. apart, and the suspenders are attached to the cables by being bolted to the lugs of a 5 × ⅝-in. steel band, which tightly clamps the cable. All long suspenders consist of wire ropes. They are attached to the floor beams by means of two adjustable screw rods, which go through a plate riveted to the under side of the bottom chord of the floor beams, and are held in place by nuts. This makes practically a rigid connection, but there is enough elasticity in the long ropes to comply with all oscillations of the bridge without causing appreciable extra stresses. The short suspenders, which extend over a length of about 375 ft. in the center of the span, consist of solid steel rods 2½ ins. in diameter. As these are the rods that broke, and as doubts have been expressed by some experts about the quality of the material, I will mention the specifications on which these rods were manufactured. They were to be of mild steel, having an ultimate strength of 75,000 lbs. and an elastic limit of at least 45,000 lbs. per sq. in. The ultimate stretch in 12 ins. was to be 15% and the reduction of area at the point of rupture 25%. These specifications were rigidly enforced, and I know that the actual quality of the steel surpassed the requirements of the specifications.

The attachment of these suspender rods to the cable is the same as described for the rope suspenders, but in place of a rigid connection with the floor beams the lower end of the rods goes through a trunnion which revolves in a trunnion plate riveted to the under side of the top chord of the floor beams. The rod passes through a hole in the trunnion block, and is held in place by a nut bearing against the under side of the trunnion. The axle of the trunnion is parallel with the floor beam and the trunnion block oscillates between the two channels which form the top chord of the floor beams.

This arrangement allows the lower end of the suspender rods to swing transversely to the floor beams and to move forward or backward as the trusses expand or contract without causing any bending strain in the rod. This is very important, because the length of the shortest rod is only 2 ft., while the maximum motion of the trusses near the slip joint in the center of the span was calculated to be 8 ins., though 7 ins. is the longest which actually has been observed. It can readily be seen that a rigid connection between the floor beams and suspenders would be fatal to the latter, and if the double-hinge construction as described above had not worked well the rods would probably have broken in the first hot summer or cold winter after the bridge was completed.

Chief Engineer Martin, in his report to Commissioner Shea, ascribes the cause of the accident to a probable defect in one or two of the rods which were broken perhaps a year or more ago, throwing additional load on the adjoining rods, which could not sustain so much weight, and broke. In doing so, still greater loads were thrown on the next adjoining suspenders, which broke in turn, and so on. While this theory may explain one of the factors in the case, I don't think it conveys all the facts. In the first place, by the rupture of one rod only a small portion of the dead weight is transferred to the adjoining suspender, which is insignificant; but even if this load were doubled or tripled the rod would be strong enough to bear it. In the second place, if it were true that the suspenders broke successively on account of the accumulation of weight on the rod next to the broken rods, there is no reason why the breakage should have stopped after nine rods were broken and why it should not have gone on until all suspenders had broken. The net section of one of the suspender rods is 3.7 sq. ins., which gives an ultimate strength of 138 tons, and the largest load calculated to come on one of these rods was 17½ tons, or only one-eighth of its breaking load. While it is a fact that the live load on the car tracks, distributed over the whole span, is at present three times larger than originally calculated, it is not true that the concentrated loads have increased very much. In place of 17½ tons, it is possible that one of these suspenders may sustain now an occasional maximum load of 22 or 23 tons, which, however, is far within the limit of safety, and could not have been the cause for rupturing any of the rods.

The cause must, therefore, be sought somewhere else. It will be remembered that the total temperature motion of the trusses is 7 ins.—that is, 3½ ins. expansion and 3½ ins. contraction, counted from a neutral point at average temperature. If the suspenders hang perfectly plumb at mean temperature, their lower ends will move towards the center of the span for from 3½ to 0 ins., beginning with 3½ ins. for the shortest suspenders in the center of the span and ending with 0 for the longest suspenders near the towers, giving (exaggerated) the bridge the appearance shown in the accompanying sketch:

It can readily be seen that the swinging motion of the shorter suspenders must cause an upward deflection of the trusses (as shown in a dotted line), and if the latter were absolutely rigid nearly every suspender rod would be bound to break. As it is, the trusses are flexible, and as the upward deflection amounts only to ¼-in., if the suspenders are plumb at mean temperature, it requires but little force to produce this deflection of the trusses, which does not exceed three or four tons in each of the suspender rods.

While the hinge construction at the short suspender rods answered all purposes under normal conditions, there is reason to suppose that the latter have been disturbed in course of time.

Occasionally the cable bands did not offer sufficient resistance and shifted on the cable, or were intentionally shifted, to accommodate the direction of the suspender rods. In this manner the original adjustment became displaced, and it is probable to assume that the rods which broke, in place of 3½ ins., may have swung 7 or 8 ins. out of plumb, which at once would make the temperature stresses five or six times larger than they would be under normal conditions. There is also not sufficient room between the top chord channels for so much motion. The suspender would bear against the edge of the channel and would bend. It was also observed that the trunnions were covered with rust, which must have caused considerable frictional resistance to the free oscillation of the rod and therewith increased the bending stresses. Lastly, it could be observed that the bridge is subjected to strong lateral vibrations, which cause constantly reversed bending strains in the rods as soon as they are

rusted in the hole of the trunnion block in place of freely moving in the latter.

In my opinion, it is probable that a combination of all the circumstances mentioned must have happened, which easily could have produced sufficient tension in the rods to break them.

It seems to me that while this was certainly an extreme and rare case, precautions should be taken to prevent a recurrence of this combination of unfavorable circumstances, improbable as it would be if the proper vigilance be taken.

At the construction of the Covington & Cincinnati suspension bridge, which is built on the same plan as the Brooklyn Bridge in regard to providing for expansion and contraction, I abandoned the hinge arrangement of the short suspenders and devised means to hold the latter always in a vertical position by introducing a roller-bearing under every floor beam for about 100 ft. each side of the center of the span. This works very satisfactorily, and if the same arrangement should be adopted at the Brooklyn Bridge for about 160 ft. on each side of the center there would be no repetition of suspender rods breaking or of a scare about the safety of the bridge, as was the case on July 24.

Having made one suggestion for increasing the safety of the Brooklyn Bridge, I venture to make another. This refers to the accident of three years ago, when one of the bottom chords buckled. If the bottom chords of the trusses within the stay system be strengthened beyond any doubt of weakness and if the stay system be modified a little to meet the temperature changes better than they do now, I would consider the Brooklyn Bridge perfectly safe, even with the additional dead weight which these changes would require.

The original dead weight of the center span was about 4 tons per lin. ft., and the live load 1 ton. With these loads the safety factor of the cables was 4½. I understand that about 500 tons have been added to the main span since the bridge was completed. Suppose the proposed changes would add 800 tons more, while the trolley traffic has added about 1,000 tons, the total increase would be 2,300 tons, or 1.44 tons per lin. ft. This, added to the original load, makes a total of 6.44 tons per lin. ft., which would reduce the safety factor to nearly 3½. This is still better than engineers consider necessary in modern bridges of large spans where a factor of 3 has generally been adopted.

These figures are, of course, only approximate, but they show clearly that, while the Brooklyn Bridge has a few points in same details which should be improved, it has plenty of strength in the cables, which are the true backbone of the bridge. Under the supposition that the structure is in perfect state of preservation, it is capable of accommodating safely all the traffic it bears now without restricting the trolley cars to run at specified intervals and without giving occasion for apprehending danger or alarming the public at every slight mishap that may occur. Very truly yours,

Wilhelm Hildenbrand.

New York, N. Y., July 31, 1901.

Sir: In the article on "The Accident to the Brooklyn Bridge," published in Engineering News of Aug. 1, there are several inaccuracies to which I desire to call the attention of yourself and all engineers in order that misunderstandings in reference to the strength of the ruptured detail may be cleared up. I think the explanation will serve a valuable purpose to many engineers. The reasons why I feel compelled to make the explanation are the following:

When acting as assistant to Mr. Wm. Hildenbrand, then chief draftsman and actual designer of the bridge in its present shape, it was my pleasant duty and privilege to design a pendulating hanger to be used on the New York and Brooklyn Bridge near the slip joints at center of main span.

Several designs were offered by others, but after a lengthy discussion, Col. Washington A. Roebling, chief engineer, adopted the design suggested by myself; this is now in actual use.

Upon commencement of the fabrication of the superstructure at the Edge Moor Bridge Works, Wilmington, Del., I was selected to proceed there and act as shop inspector under Mr. Wm. Hildenbrand, and as such supervised the manufacture and testing of these suspender rods, accepting them as satisfactory, they having fulfilled every requirement as laid down in the specifications. In view of the recognition that these rods were to act like any oscillating trunnions in a machine which is in constant slow motion throughout its life, and because the action of sliding friction would cause the trunnions and their bearings to wear, even when well lubricated, the rods and trunnions were not made of mild steel as you stated, but of a superior quality much stronger and harder than that used in the trusses.

This steel was to show an elastic limit of 45,000 lbs. and a tensile strength of 75,000 lbs. per sq. in. Tests of these rods after completion showed greater strength than prescribed and a yield point of 55,000 lbs. per sq. in. The latter is the essential criterion of material subjected to wear as in a moving machine; tenacity is of secondary importance in such a case.

In designing these suspenders it was assumed that the cable bands were clamped firmly on to the cables and would never be shifted or allowed to move. The suspenders were designed to have ample bearing surface on trunnions to move readily under all loads when lubricated, when acted upon by varying lengths of trusses due to thermal variations in themselves as well as in the cables, and without producing greater wear than is permissible in any well-designed machine. The suspender rods were made of ample thickness to prevent bending of the rods under frictional resistances of the trunnions.

The longitudinal stress along the cables due to obliquity of suspenders when in their extreme positions is not sufficient to slip the cable bands when the latter are properly clamped on the cables.

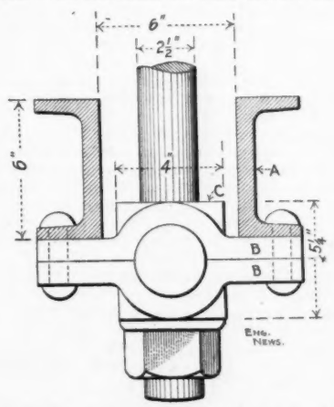
The trunnions were not made of "cast steel," as you state, but were forged to their final shape from blooms. As designed, the dimensions of all parts of the suspenders are such that they would never have jammed, bent or slipped the cable bands, nor even produced excessive abrasion and corrosion of the trunnions and their bearings.

You also state that "the chief trouble undoubtedly lies in the faulty design of the floor-beam hinges. This fact was recognized at the time the designs were prepared, but no way was then seen of remedying it."

With above explanations you must admit that this is somewhat incorrect. Their faulty design was never recognized and much less admitted by any one, least of all by Colonel Roebling, who approved of them.

Again you state, "and in designing the corresponding members for a more recent suspension bridge the same engineer discarded entirely the design he had formerly used on the Brooklyn Bridge, and substituted another which the experience of the intervening years had convinced him to be superior." The facts in the case are that the engineer in question saw that these suspenders were not acting properly, but had neither time nor opportunity to study the reason thereof. It is only now, after their failure, that he has learned the reason thereof, and does not name the cause as "faulty design."

Personal inspection of all the broken suspenders did not show any defect in the material of any rod, but it showed that these rods had been breaking piecemeal in small parts during a period extending over several years. You also state that "a glance at the sketch of the hinge connection to the floor-beam will show that the lower end



of each rod sets in a veritable pocket, into which everything can get which is not wanted, and into which it is practically impossible to get the thing most wanted, namely paint." I desire to point out that if this "pocket" had been filled with paint (and once in it, it could never have got out again), as is customary in other cases, corrosion would never have taken place.

The accompanying sketch gives some details of these suspenders which will prove their ample strength and correct design. In order that the same device may operate satisfactorily during the life of the bridge it is only necessary to:

(1) Clamp the cable bands tightly and keep them in proper position, instead of permitting occasional unnecessary shifting.

(2) Lubricate all moving parts under all atmospheric conditions.

(3) Apply sufficient paint whenever necessary to prevent corrosion. Very truly yours, Gus. C. Henning.

New York, N. Y., Aug. 5, 1901.

Sir: I have been greatly interested in the public discussion of "the accident to the Brooklyn Bridge," and am pleased to read in the Engineering News of Aug. 1 your valuable article. One point which you have not mentioned seems to me worthy of note at this time, and I hope that it will find expression through your columns. You say that "the bridge trusses have a maximum movement due to extremes of temperature of from 10 ins. to 14 ins.," etc., at the expansion joints shown in your sketch, and "were this free swing not provided (in the hinged connections) the effect of expansion and contraction would obviously be to bend the rod alternately backward and forward in the line of the bridge." The movement at the expansion joints due to temperature changes must be gradual, and hence would give the trunnions time to move gradually in their bearings without suddenly bending the suspender rods where rust made the action tardy. The frequent change in the catenary of the cable under the moving train loads causes a vertical fall and rise, which causes the ends of the stiffening trusses at the expansion joints to move rapidly toward and from each other in the line of the bridge. This change is so sudden that the trunnions must move freely in their bearings if the bending of the rods is to be avoided, and hence must have been a large factor in the breaks that occurred. Very truly yours,

J. Calvin Locke.

818 Marcy Ave., Brooklyn, N. Y., Aug. 1, 1901.

National Aid to Irrigation: A Bill to Come Before the Next Congress.

Sir: On June 20 last, a conference of the state engineers of the arid states was held in this office for the purpose of embodying the views of those present in an irrigation bill to be presented to Congress at the next session. In your comments on this bill, as the same appear in Engineering News of June 27, it is stated that there is a division of responsibility that will lead to friction, delay and expense, if not to corruption and bad work. I think a fuller inquiry into the provisions of the bill than could be secured through the meager press reports, might lead to a different conclusion.

The object of the conference, briefly stated, was to devise some plan for securing national aid in the reclamation of desert lands through the conservation of flood waters. The bill appearing below was the product of this meeting. It is the result of much discussion, some divergence of views, and an earnest desire on all sides to formulate a measure applicable to the varying conditions that obtain in the different arid states and territories. The bill as unanimously adopted, is as follows:

BE IT ENACTED BY THE SENATE AND HOUSE OF REPRESENTATIVES OF THE UNITED STATES OF AMERICA IN CONGRESS ASSEMBLED:

That all moneys received from the sale or disposal of public lands in Arizona, California, Colorado, Idaho, Kansas, Montana, Nebraska, Nevada, New Mexico, North Dakota, Oregon, South Dakota, Utah, Washington and Wyoming, beginning with the fiscal year ending June 30, 1902, excepting money set aside by law for educational purposes and excepting also the salaries and commissions of registers and receivers of the United States land offices located in said states and territories, shall be and are hereby reserved, set aside and appropriated for the benefit of the said state or territory in which said lands were sold or disposed of to be kept as a special fund in the treasury to be known as the "Arid Land Reclamation Fund," and shall be under the direction of the Secretary of the Interior for the examination, survey and construction of reservoirs and other irrigation works for the storage, diversion and development of water as hereinafter provided, so that the same may become available for the reclamation of arid or semi-arid lands and for the payment of all disbursements provided for in this act.

Sec. 2. Any of the above-named states or territories desiring to avail itself of the benefits of this act shall enact a law or laws accepting its conditions, and shall create a state engineer's office with authority to make examinations and surveys, plans and estimates for reservoirs and other irrigation works, to be built and paid for out of the money deposited to the credit of such state or territory in the arid-land reclamation fund, and such law or laws shall provide for the supervision and control, or sale, as hereinafter provided, of such works, and the storage, division, disposal and distribution of the water so rendered available. And said state or territory shall also, as a condition precedent to receiving the benefits of this act, provide for the orderly and final establishment of rights to the waters within its borders so rendered available, and shall restrict by law all such rights to the actual beneficial use of the same, and no state or territory shall be entitled to the funds in the treasury reserved for its benefit until after the enactment of such legislation.

Sec. 3. Any state or territory having complied with the provisions of this act, may, through the authority designated by the state law, file with the Secretary of the Interior, maps, plans and estimates for the construction of reservoirs, or other irrigation works, to be paid for out of the funds deposited in the treasury for the benefit of such state or territory; said maps, plans and estimates to designate the location of said works; the volume of water thereby rendered available; the lands upon which the water is to be used, and the revenues, if any, to be derived from the rentals of the water so made available:

Provided, that such revenues over and above the amount necessary for maintenance and distribution shall be credited to the arid land reclamation fund for the benefit of such state or territory for the construction of reservoirs and irrigation works, and

Provided further, that any state accepting the provisions of this act may sell the completed works to the actual consumers of water only, the proceeds of such sale to be likewise credited to the arid land reclamation fund of the state or territory constructing such works.

Sec. 4. It shall be the duty of the Secretary of the Interior to examine, or cause to be examined, the plans and estimates for the construction of reservoirs, or other irrigation works, submitted by any of the above-named states or territories, in order to ascertain if said plans are feasible and the estimates reliable; and he shall have authority to approve, if satisfactory, or to amend or reject any of said plans in case the projects are considered not feasible, the estimates of cost unsatisfactory, or if the amount of money required for their construction should be in excess of the sum on deposit in the treasury to the credit of said state or territory. On the approval of said plans, the Secretary of the Interior shall order to be set aside and appropriated from the funds of the treasury to the credit of the state or territory submitting the plans and in which the water is to be utilized, the amount of

money designated in the estimate as the cost of construction and the state engineer shall thereupon be authorized to proceed with the construction of said works, the cost of the same to be paid for out of said fund on vouchers signed by the state engineer and approved by the Secretary of the Interior.

Sec. 5. That from and after the date of the filing of said plans for the construction of reservoirs, or other irrigation works, submitted by any of the above-named states or territories, the public lands designated upon which the water is to be used or upon which the proposed works are to be situated, may be segregated and withheld from public entry during the time of construction of said works, and permanent right of way upon and over the public domain is hereby granted for all works constructed under the provisions of this act.

Provided, that lands segregated and withheld from entry by this act may be filed upon under the U. S. land laws, such filing to be refused unless accompanied by evidence of a permanent water-right therefor.

Sec. 6. That where, in carrying out the provisions of this act, it becomes necessary for the construction, operation or maintenance of any proposed reservoir or irrigation works to acquire any right to property, either by purchase or by condemnation under judicial process, the cost of such property or right shall be paid out of said "Arid-Land Reclamation Fund" as provided for in the payment of cost of reservoirs and other works in section 4 of this act.

Sec. 7. The Secretary of the Interior is hereby authorized and directed to provide such rules and regulations as may be necessary to carry into effect the provisions of this act.

The central idea of the bill is that the money shall come from the states to be benefited by it and from them alone. There is to be no tax, either direct or indirect, upon the humid states for irrigation, nor are the educational or land-office fees which are now provided for from the receipts of sales of public lands to be curtailed in any way.

The work of the government is to continue without interference or interruption, the intent being to provide a law that would require the enactment of no other law preliminary to its going into effect, thus avoiding complications and the delays and opposition that always attend them.

The first section limits the expenditures in any state to the receipts from that state because it was unanimously believed that any attempt to expend the receipts from one state for construction work in another would simply invite a continuance of that opposition to this plan which has heretofore defeated every irrigation bill introduced in Congress. It appeared to the conference that even the largest sum to be received by any state was far too small to admit of its division for use elsewhere, and, on the other hand, that in the large majority of the arid states valuable construction for irrigation purposes should be compassed, if not every year, at least biennially, under the bill.

The bill differs from all others heretofore introduced in Congress in providing that the expenditures shall be made by the states upon sites to be selected by themselves. It was felt by the conference that only the complete and thorough information found in the state offices having the water appropriation in charge should or could be relied upon to determine when a reservoir is needed and where it should be located to attain the highest good. The accurate, complete and reliable information already acquired by many of the arid states, coupled with their facilities for obtaining data within their immediate boundaries, make them pre-eminently the proper authorities for determining these matters.

It is also provided that the works shall be self-maintaining and the reclamation fund self-renewing, if the states shall, respectively, so determine. This, however, was left optional for the reason that, in some states, a revenue above the maintenance figure might not, in every instance, be desirable, while, in others, especially those having only a small fund to draw from, it would be imperative.

The control of water, its diversion and appropriation, is left entirely to the states, partly because they already control far the larger portion of available water under their present laws, and a division of authority could not but work injury to all concerned, and partly for the reason that, through a long series of years, they have demonstrated the peculiar fitness of the state governments to take charge of this work. In several of the arid states, the water laws are such that for the proposed law to go into operation, nothing more will be required than a simple legislative acceptance of its provisions and conditions; in others, some amendments to their laws determining water rights will have to be made, and this requirement was made a part of the bill to the end that as far as possible future litigation over these waters might be prevented.

The provision permitting the actual consumers of the water to ultimately become the owners of the works is in accordance with advanced public sentiment in the West, because it is certainly in the interest of the settler himself in that it secures him against possible extortion under alien ownership, for his prime necessity. From the discussion on this provision, it appeared probable that some of the states might wish to divert the waters and maintain the works themselves, but that none should be debarred from disposing of them to actual consumers only, should the latter desire to carry the burden.

The segregation of the lands upon which the works shall be situated is to prevent the vexations, delay and expense incident to securing a right of way through private holdings filed after notice of construction had become public. The segregation of such portions of the lands to be reclaimed as belong to the public domain, is for the purpose of securing in their selection of homes equal opportunities to all.

The acreage to be acquired by any one person is the same as that which he may obtain under the land laws now in force. In a very large majority of the arid states he could not possibly live upon less, and, although in some extremely limited portions of California, "40 acres may be a principality," the conditions there are so exceptional that Congress has not yet seen fit to change our homestead laws on that account. It is safe to say that a law restricting the area to be owned by each settler to a tract of 40 acres, would not build a single home in the Rocky Mountain region.

For the purpose of preventing speculators from getting control of the irrigable land for other than reclamation purposes, and thus defeating the intent of the act, it is provided that land filings can only be received when accompanied with evidence of a permanent water right under state laws.

Responsibility is divided between the state and the nation, but the authority of each is so clearly stated that there can be no question as to where the one ends and the other begins. The state determines where a reservoir is needed and makes the plans, specifications for construction and estimates of cost; the Secretary of the Interior then examines all of these and rejects or approves as may to him seem proper. If he approves, he orders the funds, or such portions as may be necessary and previously placed to the credit of the state, set aside for this particular project. The state engineer then proceeds with the work in the manner to be determined by the state laws. This is not fixed in the bill, however, it being apprehended that certain of the states might wish to undertake the work direct, while others would prefer to let a contract secured by suitable bond; or, depending upon local conditions, both methods might be advantageously employed in the same commonwealth.

Finally, the Secretary of the Interior is not only empowered, but is directed to make suitable regulations for carrying the law into effect. Among these, and without causing the Secretary to suffer the imputation of having undertaken new legislation, should be one governing the filing of plans and estimates; another for accounting for rentals, if such be authorized by any state; a third for the segregation of lands; a fourth for the examination of the completed works, should this be considered necessary, all of which could be provided and thereafter acted upon with such promptness as would in no way interfere with the work on hand in the states.

In conclusion, it might be stated that the most pertinent criticism of the measure yet seen by the writer is one declaring its inadequacy for the purposes intended; and when the fact is recalled that, at the present rate of selling the public lands, it would take 28 years to secure for irrigation the amount provided for a single year's expenditure under the late defeated River and Harbor Bill, the sum asked for appears modest, indeed!

It will, nevertheless, be an important aid to irrigation in the arid states, and, beyond question, will fill with new homes many thousand of acres of the public domain now barren, unproductive and impossible of reclamation under present conditions. Very truly yours,

Fred. Bond, State Engineer.

Cheyenne, Wyo., July 16, 1901.

Sir: My attention has been called to the editorial in Engineering News for June 27, 1901, relating to the State Engineers Bill, which was presented to the meeting at Cheyenne on June 20, and I have read the editorial with very deep interest.

All Western senators and congressmen were notified of the proposed meeting at Cheyenne, but it was only attended by Senator Warren, who lives at Cheyenne; Representative Mondell of Wyoming, Representatives Burke and Martin of South Dakota and Representatives Burkitt and Shallenbarger of Nebraska.

The bill was understood to have been drawn by State Engineer Bond of Wyoming and by him presented to a meeting held at the State Engineer's office during the day, which was attended by the state engineers of Wyoming, Idaho, Colorado, Utah and Nebraska. The state engineers naturally approved the bill. It would increase the importance and patronage of their office.

The bill was presented to a meeting of Senator Warren and the representatives above named in the evening, but after discussion the meeting adjourned with the distinct understanding that no action whatever had been taken with reference to the bill. The chairman of the committee, Representative Burkitt, was requested to call a meeting of all Western senators and representatives to be held in Washington about the time that the next session of Congress convenes.

I was very much gratified to note that you had seen the defects in this bill proposed by the state engineer of Wyoming, and deemed the subject of sufficient importance to merit editorial comment. I have given the whole subject of the reclamation and settlement of the arid region the most careful investigation and study for a number of years past, and I have become profoundly convinced by the experiences of a generation, and the results of all efforts at irrigation development through various schemes for enlisting the states in the work, either through grants of land or money, that just to the extent that the states are mixed up with the matter, complications and delays will result which will retard or entirely prevent the actual reclamation and settlement of the arid public lands.

As you are, of course, aware, for many years the controversy between the advocates of the cession of the arid lands to the states, and of the reclamation of the arid lands by the National Government, has been very bitter, and I think every one now recognizes that the consequences of state cession would have been deplorable, and that the opposition to this policy is so strong that it can never prevail. The great current of public sentiment in the West was well expressed in an editorial in the "Los Angeles Times," where it was said:

State cession is eternally wrong, and the Federal reclamation of the arid lands, which the government owns, is eternally right.

The latent influences behind the state cession movement were the speculators and large stockmen, who believed that through the manipulation of state legislatures they could get control of the public lands in large bodies.

Having been defeated in their determined efforts to secure the cession of lands to the states, they are now seeking to accomplish practically the same results by a different plan. The fact must never be lost sight of that there is in the West a second great "irrepressible conflict" between those on the one hand desire the reclamation and settlement of the arid region in small farms and the creation of a dense population which will promote the general prosperity of the whole country, and on the other hand, the interests which desire to control the public lands in such a way that they may be gradually absorbed into great stock ranges which will bar the settlement and development of the country.

No better illustration could be had of the results of entrusting the states with the management of the public lands than the conditions which exist to-day in Nevada. That state secured the passage of an act of Congress permitting it to take two million acres of land as a flat grant, with the privilege of locating it wherever it chose, in lieu of its school land grant of the 16th and 36th sections. The state land officers sold this land for a mere trifle to the stockmen, who have located it so as to control every available drop of water in the state of Nevada, in its natural courses and channels, and by thus controlling the water they control the range, and although there are 42,385,735 acres of public land in Nevada, there is not a quarter section of land in that state upon which a homestead settler can go and get water to irrigate enough of it to yield a living from it. This condition of affairs is detrimental to the whole nation. The population of Nevada, small as it is, has been decreasing during the last ten years. Yet there is land enough in that state which could be reclaimed by utilizing the flood waters which now go to waste to support a population of more than a million people, and to transform Nevada from an almost uninhabitable waste into a prosperous commonwealth, contributing her full share to the internal trade and commerce of the country, and consuming an enormous quantity of the products of the factories of the East. Every new farmer in Nevada would be a new consumer for the Eastern manufacturer.

Now, is it possible that any reasonable and unprejudiced man could believe that these conditions in Nevada can ever be overcome or changed by any plan or scheme which would give the public lands in the state or the proceeds of their sale or rental to any state legislature or state officials subject to the control of the local influences which have already absorbed everything that has been donated to the state and absorbed it in such way as to control the rest of the public domain and prevent its settlement.

Wyoming seems to be prolific of measures which in one way or another would, if enacted, enable the range interests to control the public domain. Their idea seems to be, by any possible scheme or device, to promote the creation of state engineering bureaus and state land bureaus, so as to get state officials into office, who will work, as the state engineers of the few states now having such officers are doing, to get the control of the public domain away from the National Government and into the states where it can be manipulated so as to promote the interests of those who desire to control the range. I enclose a clipping from the "Great Falls News" of Jan. 18, 1900, containing a copy of what was known as the Mondell Leasing Bill in the session of Congress before last. This bill aroused such a storm of protest in the West that its proponent, Mr. Mondell himself, moved to lay it on the table. It is a very interesting course of reading, to read first the Mondell Bill, and then the Bond Bill and then the John P. Irish editorial, and then to consider what the consequences would be of a composite measure amalgagating the provisions of the Mondell Bill and the Bond Bill, as suggested by Mr. Irish in his editorial.

The State Engineer's Bill has been severely criticised and condemned, and the only favorable comment which

I have seen of it, outside of Wyoming, so far, is the editorial in the "San Francisco Call." Col. John P. Irish is the editorial writer for the "Call" on these subjects. He advocates leasing the grazing lands and building irrigation works with the revenues. Now suppose that the suggestion of his editorial in the "Call" was adopted, and the cattlemen of Nevada, who now control the range by controlling the water, were enabled to still further entrench themselves by leasing at a very low rental the area which they range over, and the funds from this source and from the sales of public lands were to be turned over to a state engineer, ostensibly for the purpose of irrigation development, is it conceivable that these strong vested interests would permit the carrying out of a policy by the state which would actually accomplish the settlement of the state by the multitude of small settlers and stock raisers who would gradually necessarily displant those who now enjoy and occupy the public domain in that state and are realizing enormous profits from its occupancy? The question answers itself, and any one familiar with the methods by which the public lands in the West have been controlled in the past, knows perfectly well that under such a bill as the State Engineer's Bill not an acre of land would ever be opened for actual settlers under the homestead act. Under that bill the funds need not necessarily be expended to reclaim public lands, and if any irrigation works were built in Nevada they would be built to provide water for lands to which settlers would never have access, and under the clause of the bill which permits the sale of the works to the users of the water, the large landed interests would acquire the works, and the possibility of reclaiming and settling Nevada would be gone forever, because when the water resources of any of the arid states have become vested rights in private ownership they are practically impregnable.

The only way in which the great arid region can ever be reclaimed and settled by a dense population is to adhere inflexibly and irrevocably to the principles advocated by the National Irrigation Association, and to condemn every scheme presented which proposes to turn either the land or money from its sale over to state politicians. The National Government owns the land and has no purpose to subserve, but to put settlers on it. It should and must build the great reservoirs and main-line canals necessary to bring the water within the reach of settlers on the public domain, wherever this can be done without complications with existing vested rights to water. The greater part of the irrigable arid public lands can be reclaimed in this way without any danger of such complications. In other words "Uncle Sam" can, should, and must do with the great domain which he owns in the West, which embraces 100 million acres of irrigable arid lands, just what any private person or private company could do if they owned the land and desired to settle it; that is, build the great works which are beyond the scope of the co-operative enterprise of the settlers themselves, so as to bring the water within the reach of settlers, and then let the settlers build the distributing systems as they have been doing everywhere in the West where the water was within their reach.

In the last session of Congress this whole subject was fully discussed in extended hearings before both the public lands committee and irrigation committees of the House, and a bill was favorably reported from both committees. There were defects in both these bills, but the bill from the irrigation committee had great merit. Subsequently a revised bill was introduced by Representative Newlands of Nevada, with a view to meeting every reasonable objection which has been urged before the committee, and I enclose a copy of that bill. I also send you copies of the report of the hearings before the committee.

The National Irrigation Association has now a membership of over 1,500 of the leading business concerns of the country, and the endorsement of many of the most influential commercial organizations, such as the National Business League, National Board of Trade, St. Louis Manufacturers' Association, Omaha Commercial Club, St. Paul Chamber of Commerce and Commercial Club, Los Angeles Chamber of Commerce, Merchants' & Manufacturers' Association and Board of Trade, and many others that I might mention. Our association has been organized and proceeds upon the theory that the reclamation and settlement of the arid public domain in the West is not in any sense a local or sectional question, but is a great national problem, just as much so as the building of the dikes of Holland, or the Nile dam, or the irrigation works of India were national problems.

The principles which we advocate are:

(1) That no grants of public lands should be made to the states or territories, but that the National Government should reclaim the arid public domain.

(2) That the National Government should build reservoirs as a part of its policy of internal improvements, just as it builds river and harbor improvements, as recommended in the Chittenden report.

(3) That the National Government should, wherever necessary for the reclamation of the arid public lands, build the great reservoirs and canals needed to bring the water within the reach of settlers on the public land, and that all lands for which water is thus made available should be reserved for actual settlers only under the homestead act, who should repay to the government in annual installments extending over a long period of years and without interest the actual cost of irrigation works built by the government.

To carry out these principles, we intend to ask the next session of Congress for the following action:

(1) To increase the appropriation for irrigation investigations and surveys by the United States Geological Survey from $100,000 to $250,000 per year.

(2) For an appropriation in the River and Harbor Bill to begin the construction of a reservoir on the headwaters of the Missouri River in order to inaugurate the Chittenden policy.

(3) To enact a measure creating an arid land reclamation fund from the sales of public lands in all the Western states and territories, to be expended by the Secretary of the Interior directly, without the interposition of any state engineers, state politicians, state legislatures, or state machinery of any kind; the cost of the irrigation works to be added to the price of the land reclaimed, and such lands to be reserved for actual settlers only under the homestead act.

H. R. 14,338, introduced by Representative Newlands of Nevada in the last session, embodies this general plan, but should be still further safeguarded against speculative entries. The commutation clause of the homestead act should be inapplicable to lands for which water is provided under this bill.

I trust that you will pardon the liberty I have taken in writing you at such length. I should not have done so, but for my conviction of the over-shadowing importance of the subject to every business interest of the country.

Very truly yours, George H. Maxwell,
Executive Chairman, National Irrigation Association.
1707 Fisher Building, Chicago, July 6, 1901.

A PROPOSED VENTILATING SYSTEM FOR THE PARK AVE. TUNNEL, NEW YORK CITY.

By Albert A. Cary, M. Am. Soc. M. E.*

During the recent Grand Jury investigation of nuisance existing in the Park Ave. tunnel, between 56th and 96th Sts., in New York city, I was called by Assistant District Attorney Charles E. Le Barbier, as engineering expert in ventilation, and in my testimony before the Grand Jury presented the system of ventilation described in this article.

The greater part of the Park Ave. tunnel (as it is called) might be considered more as a partial subway. It contains four tracks, the two outer ones being placed, through the greater part of the tunnel's length, in what is known as the side tunnels, while the other tracks are located in one "center tunnel." The greater part of the center tunnel has openings in its top, while the side tunnels are closed excepting a series of archway openings in the top of the 20-in. dividing walls, separating them from the center tunnel. Thus, a part of the steam, gases, smoke and cinders escape through these openings into Park Ave. and become a nuisance, as they blow into the adjoining houses, as was testified by numerous witnesses.

Park Ave. is a broad street, measuring about 96 ft. in width from curb to curb. Through the center of the avenue are located a series of parkways about 40 ft. in width and slightly less than 200 ft. in length, their ends, at the intersections of the crossing streets being semicircular. In the center of the parkways the openings from the center tunnels are located, while grass and shrubbery surround these openings, extending to the stone copings around their outer edge, and on these copings an ornamental iron fence is placed. Over the four tracks running through this tunnel all the trains passing in and out of the Grand Central Depot are run, and these include the trains of the New York Central & Hudson River R. R.; the trains of the Harlem Division of the New York Central & Hudson River R. R.; and those of the New York, New Haven & Hartford R. R. Between 500 and 600 trains pass through this tunnel every day, and at times there is but 50 secs. headway between trains. The average time required by trains to traverse the tunnel is about 3½ mins., when no stops are made and no delays encountered.

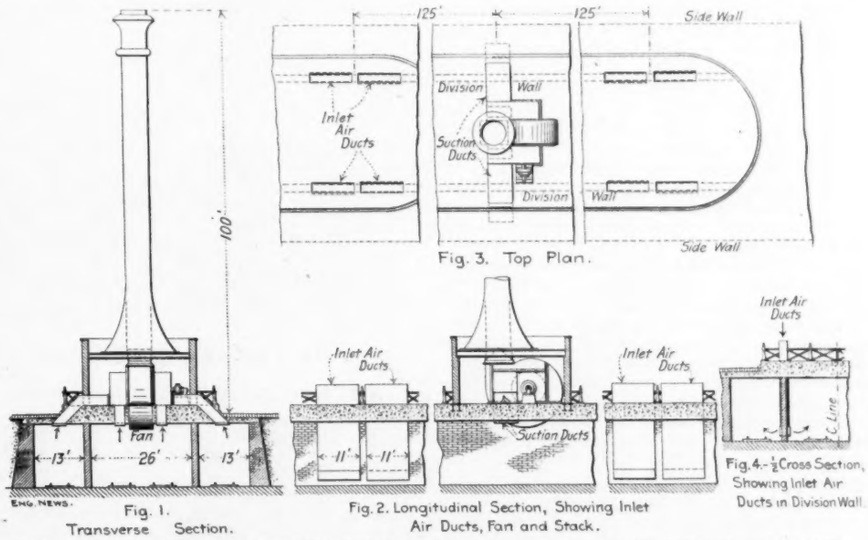


Fig. 3. Top Plan.

Fig. 1. Transverse Section.

Fig. 2. Longitudinal Section, Showing Inlet Air Ducts, Fan and Stack.

Fig. 4.—½ Cross Section, Showing Inlet Air Ducts in Division Wall.

FIGS. 1 TO 4. SYSTEM OF MECHANICAL VENTILATION FOR PARK AVE. TUNNEL, NEW YORK CITY.
Designed by Albert A. Cary, 95 Liberty St., New York City.

The condition of the atmosphere in the tunnel and that in the passenger cars passing through the tunnel were investigated by Dr. Cyrus Edson (formerly President of the New York Board of Health), Dr. Chas. A. Doremus, and by officers detailed for this purpose by the Board of Health, and Dr. Edson, in his report, made the following statements:

> In my opinion, the tunnel is the cause of a very serious public nuisance, affecting the health and comfort of a very large number of persons. This is mainly caused by the gases of combustion and other deleterious gases, which enter the cars passing through the tunnel, and the lack of proper ventilation of the tunnel and the cars. Each car contains less than 5,000 cu. ft. of air space, and, therefore, allows only about 56 cu. ft. of air for each person.
>
> The temperature in these cars during the warm weather varies from 85° to 105° F. I have noted a temperature of 111° F. with a high percentage of humidity. The gases of combustion, plainly apparent to the senses while the cars are passing through the tunnel, are very poisonous and in sufficient quantities will destroy animal life.

After a careful consideration of the existing conditions of nuisance, and after studying various methods for its suppression, I have arrived at the conclusion that mechanical ventilation was the most practical solution of the problem, which conclusion led me to submit the system described in this article, to accomplish the rapid removal of the greater part of the smoke, steam and noxious gases from the tunnel, and at the same time providing for the introduction of an ample supply of fresh air into the tunnel.

*93 Liberty St., New York city.

In any system of ventilation it is a positive necessity for successful working to have the air enter and leave only at the points designed, and therefore it will be understood that it will be necessary to entirely close the openings over the top of the central tunnel, now left open, and fresh air will then have a positive inflow through the intake ducts provided, while the foul atmosphere is positively discharged through the suction openings leading to the fans.

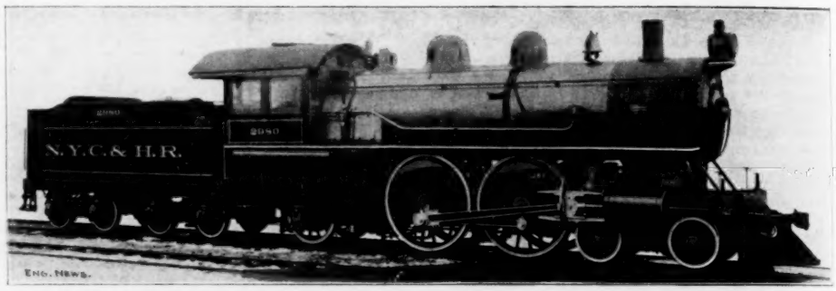
By referring to the accompanying illustrations three sectional views of the tunnel will be seen, marked Figs. 1, 2 and 4, while Fig. 3 shows a plan view (looking down upon the parkways in the center of Park Ave.). The views of the tunnel shown here are drawn from dimensions obtained by me between 61st and 62d Sts. In Fig. 1 is shown a sectional elevation at a point about midway between 61st and 62d Sts., where I propose to place the suction fan and chimney. The fan casing will be seen (with its lower portion shaded) above the middle of the center tunnel. On each side of the fan casing will be seen inlet air boxes, which collect the foul air from the suction flues, and this air is drawn from these boxes into the fan casing, from whence it is discharged through the chimney into the outside air. The suction flues (discharging into these inlet boxes) are four in number, the suction ends of which are placed directly over the center of the four tracks shown, and as I propose to place a fan in the center of each block, it will be seen that the locomotive smokestack will pass under one of the exhaust openings about every 250 ft.

This design includes all of the necessary flues and other parts entirely within the limits of the central parkway without encroaching upon the adjoining street. The chimney shown in this design is constructed of steel plates and made graceful in outline, as shown. It is to stand 100 ft. above the street level, and to be 7 ft. in diameter. It has a bell-shaped base designed to be self-supporting (i. e., requiring no guy ropes), and is to stand upon a proper brick foundation, the details of which are not shown in the illustrations. Fig. 2 shows a longitudinal section of the tunnel from a point (at the left) just south of 61st St. to a point (at the right) just south of 62d St., while the plan view just above it shows the same location.

It will be seen that four inlet fresh air pipes are placed near the north end of each of the parkways, and with an average distance of 125 ft. from the suction pipes of the fan. These fresh air pipes drop to a point about 15 ins. above the bottom of the tunnel (to prevent water entering their lower end) where they turn with an outlet towards the center of the tunnel they supply with air. Thus it will be understood that with the two inlet pipes placed side by side, one turns its lower end towards the center tunnel, while its neighbor turns its lower end in the opposite direction, towards the side tunnel. This is shown in the sectional view in Fig. 4. Owing to the extremely limited space in the tunnel, I have arranged the fresh air flues so as to fit into cuts made in the 20-in. wall separating the center and side tunnels, and thus these flues extend but 2 ins. into each tunnel beyond the surfaces of the present walls. Provision can easily be made to carry the roof beams of the tunnels on structural steel-work where these flues are placed. The upper ends of these fresh air ducts extend about 7 ft. above the level of the street (inside of the parkways), and I propose to cover them with ventilators designed to keep out rain or snow.

The amount of carbonic acid found in the air is generally taken in ventilation work, as the index of its purity, and what is commonly considered as pure country air ordinarily averages about 4% of carbonic acid; 8% of carbonic acid is commonly considered as a standard of purity in the ventilation of buildings, while in this tunnel, should the carbonic acid present occasionally reach 12%, no serious inconvenience would be experienced by the passengers, and therefore taking 12% as a maximum allowance, I believe that with fans of sufficient capacity to exhaust all the air from this tunnel every two minutes this result could be obtained. I have included such a fan in my design, which is 12 ft. in diameter, to be run at 120 revs. per min., and requiring 40 HP. to operate it; 40 fans of this size (necessary for the complete equipment of this tunnel) would, therefore, require 1,600 HP. I would propose to operate all these fans by electric motors, connecting every alternate fan to a separate circuit, each of the two circuits being supplied with a current from separate engines and dynamos, so that in case anything should happen to the machinery connected to one circuit every second fan would still remain in operation. According to approximate figures I have obtained, the cost of installing one fan and chimney with exhaust and inlet air ducts complete, as shown in my design, should not exceed $10,000.

The London & Northwestern Ry. tunnel is about a mile and a quarter long, and has a sectional area of 430 sq. ft. The ventilation is effected by the use of a single fan 29 ft. 4 ins. in external diameter, and 7 ft. 6 ins. wide, placed in a shaft 175 ft. high and 23 ft. in diameter. With a speed of 45 revs. per min., this fan cleared the tunnel of smoke and steam in about eight minutes, discharging about 431,000 cu. ft. per min. The Park Ave. tunnel is about two miles long, and has a sectional area at the point shown in the accompanying drawing of 841 sq. ft. The proposed ventilation, according to my design, is to be effected by 40 fans 12 ft. in diameter and 6 ft. in width, and these fans, with a speed of 120 revs. per min., will have a combined discharge capacity of 4,120,000 cu. ft. per min., almost ten times the capacity of the English fan, whereas the size of the Park Ave. tunnel is only about three times the size of the English tunnel. Another most important difference between the Park Ave. tunnel and the English tunnel, is that the fresh air supply had half the length of the tunnel to travel before reaching the discharge fan, while by my proposed method the fresh-entering air is admitted every 250 ft., and the foul air also has a chance to escape every 250 ft.



ATLANTIC TYPE OF FAST PASSENGER LOCOMOTIVE; NEW YORK CENTRAL & HUDSON RIVER R. R.

A. M. Waitt, Superintendent of Motive Power. Schenectady Locomotive Works, Builders.

FAST PASSENGER ENGINES FOR THE NEW YORK CENTRAL & HUDSON RIVER R. R.

The New York Central & Hudson River R. R. has recently put in service some large passenger engines of the Atlantic type, which are intended specially for hauling the Empire State Express and other fast trains. The accompanying cut shows the general appearance of these engines, and it will be noted that the trailing truck axle under the fire box has its journal bearings outside the wheels. These locomotives have simple engines, with piston valves, and the piston rods extended through the front cylinder heads. The connecting and side rods are of H-section. The links of the valve motion have a radius of 5 ft., and the rod leading from the link to the rock shaft is curved to clear the forward driving axle. The driving wheels are set close together under the boiler, while the wide fire box extends over the plate frames in which the trailing axle is carried. The truck has Krupp wheels with wrought-iron disk centers and steel tires 3½ ins. thick.

The boiler is 5 ft. 10⅝ ins. diameter inside and has a mud drum under the waist, near the fire box. The fire box is wide, with flaring sides, and has two fire doors. The back head of the fire box is inclined, so as to give additional length at the grate. The main frames are of the usual form, but behind the main driving axle a slab or plate frame is worked in, with auxiliary outside plate frames forming pedestals for the boxes of the trailing axle. The springs of the driving and trailing axles are all connected up into one system by means of equalizers. The rear equalizer has an adjustable fulcrum, operated by a lever and a vertical air cylinder placed just behind the forward hanger of the equalizer. By shifting the fulcrum, the load may be distributed as follows (the normal distribution being given below in the table of dimensions): On driving wheels, 105,000 lbs.; on truck, 36,500 lbs. on trailing wheels, 34,500 lbs. The cylinder is supplied with air from the brake reservoir, and the operation of the device is controlled by the engineman.

The tender has a steel frame and Fox pressed steel trucks, and its water scoop (for taking water from the track tanks) is operated by air. The National hollow brakebeam is used on the tender, and the Gould coupler is fitted to both engine and tender. The Westinghouse brake is applied to all the wheels of the engine and tender, a practice which is now becoming general on engines for this class of service, the old objections to applying brakes to the truck wheels having been proved in practice to be largely unfounded.

The general designs for these engines were prepared by Mr. A. M. Waitt, Superintendent of Motive Power of the New York Central R. R. The details were marked out by the Schenectady Locomotive Works, of Schenectady, N. Y., and we are indebted to the builders for photographs and other information. The leading dimensions are given below in our standard form:

Dimensions of Atlantic Type Express Locomotive; New York Central R. R.

RUNNING GEAR:	
Driving wheels (4)	6 ft. 7 ins.
Truck wheels (4)	3 " 0 "
Trailing wheels (2)	4 " 2 "
Tender wheels (8)	3 " 0 "
Driving wheel centers	Cast steel.
Truck wheels	Krupp steel tired.
Driving wheel tires secured	Shrinkage and ret. rings.
Journals, driving axles	9½ x 12 ins.
Engine truck	Swing bolster.
WHEELBASE: Driving	7 ft.; Total engine 27 ft. 3 ins.
Tender	16 ft. 6½ ins.; engine and tender 53 ft.
Engine, truck-pin to c. leading driv. wheel	7 ft. 10 ins.
Trailing wheel to c. of rear driv. wheel	9 " 6 "
Wheels having blind tires	None.
WEIGHT IN WORKING ORDER:	
On driving wheels	95,000 lbs.
On truck	42,500 lbs.; on trailing whls 38,500 "
Engine, total	176,000 "
Tender, empty	48,900 "
CYLINDERS: No.	Two.
Diameter and stroke	21 x 26 ins.
Form of crosshead and guides	Alligator; two-bar.
VALVE GEAR: Type	Stephenson.
Valves, style	Piston; maximum travel 6 ins.
Inside lap	⅛-in.; outside lap 1 in.
Lead (full gear)	None.
BOILER: Type	Straight-top.
Diameter barrel outside smallest ring	6 ft.
Horizontal seams	Sextuple riveted.
Circumferential seams	Double riveted.
Joints	Butt, welt strips in and out.
Length of smokebox (incuding extension)	5 ft. 6 ins.
Injectors: No.	Two; kind Monitor, No. 11.
Working steam pressure	200 lbs.
FIREBOX: Type	Wide, above frames.
Length inside	8 ft. 6⅛ ins.; width inside 6 ft. 3⅜ ins.
Depth: Front	6 " 8¼ " ; at back 5 " 9 "
Thickness, side plates	5-16-in.
Back plate	⅜-in.
Crown plate	⅜-in.; tube plate ½-in.
Crown stays	Radial, 1⅛ ins.
Is firebrick arch used?	Yes; on water tubes.
Stay bolts, diameter	1 in.
Water spaces, width at front	4 to 5 ins.
At back	3½ and 4½ "
At sides	3½ and 5½ "

TUBES: Charcoal iron; No.	396
Thickness	No. 12 B.W.G.
Diam. outside	2 ins.; Length, over tube plates 16 ft.
HEATING SURFACE AND GRATE AREA:	
Heating surface, tubes (interior area)	3,298.08 sq. ft.
Firebox	180.0 "
Firebrick arch tubes	27.09 "
Total	3,505.17 "
Grate area	50.32 "
MISCELLANEOUS:	
Exhaust nozzle, single, diameter	5, 5¼, 5½ ins.
Smokestack, diameter inside	14 ins.
Height of top above rail	14 ft. 10 "
Capacity of tender tank	5,000 galls.
Coal space	10 tons.

PROPOSED GARBAGE FURNACES WITH HEAT UTILIZATION AT BUENOS AYRES, ARGENTINE REPUBLIC.

A highly creditable report on garbage disposal, accompanied by specifications for five plants with a combined capacity of 800 tons a day, was made in behalf of the city of Buenos Ayres in May, 1900. The report was prepared by a commission appointed by the city authorities, consisting of Drs. Antonio F. Pinero, Francisco P. Lavalle and Mr. Carlos Eschagüe, an engineer. The specifications appear to have been drafted by a larger commission, including the three men named. Through the courtesy of Mr. W. F. Morse, of 39 Cortlandt St., New York city, we have been permitted to abstract the following points from a translation of parts of the report. We understand that the city is about to receive bids in accordance with the specifications.

The first part of the report reviews the various garbage furnaces in use in different countries, chiefly those in England. It then lays down the general conditions necessary for the satisfactory incineration of garbage. These are: (1) A temperature of not less than 1,350° F. for the thorough combustion of all gases and 2,000° F. for the complete burning of the solids and the securing of a minimum of residue.

(2) Forced draft by means of injected steam or air.

(3) Chimney discharges free from fine ash, cinders or unburned matter.

(4) Low cost of operation, which is dependent on: (a) simple machinery and the protection of the weakest parts of the furnace from damage; (b) garbage wagons dumped as nearly to the charging holes as possible; (c) rapid charging, both to save labor and to reduce the introduction of cold air to a minimum; (d) separate charging and stoking platforms, to obviate interference of the two operations; (e) durable and simple construction in order to save repairs, and furnaces capable of operating through the whole 24 hours.

(5) While keeping bygienic conditions at the front, efforts should be made to utilize the heat of combustion. The boilers should be placed as near the furnace as possible without undue lowering of the temperature. The latter will require some space between the furnace and the boiler.

(6) The clinker and ashes should be utilized, because: (a) otherwise their disposal is an additional expense; (b) if utilized, a revenue may be secured. The slag, if ground and mixed with cement, makes excellent mortar, available for paving foundations. The fine flue ashes may serve as a base for the manufacture of disinfectants.

(7) A number of plants, distributed through the city, should be used to diminish the distance and cost of hauling the garbage.

Garbage furnaces for Buenos Ayres will be called on to consume only household garbage and market wastes. An estimate of the component parts of the garbage as now collected is as follows:

	Per cent. of weight.
Bottles, glass, earthenware, etc.	0.22
Rags and paper	2.03
Bones, meat and bread	5.60
Iron, tin, leather	0.24
General refuse, dust, ashes, etc.	91.91
	100.00

Analyses indicate that 50% of the garbage and refuse is water, 20% combustible and 50% mineral matter.

The present quantity of garbage and refuse per inhabitant is estimated at 2.2 lbs. for the main part of the city and 1.1 lb. for the two suburbs which it is proposed to include in the service. The quantity of garbage to be burned is estimated at 2.2 lbs. per capita per day for the whole population, or 800 tons in all.

At present nearly all the garbage of the main part of the city, some 690 tons a day, is hauled to dumping grounds at an expense of $2.22 per ton. It is thought that the proposed garbage furnaces would materially reduce the length of haul.

One section of the report is devoted to a discussion of the possibilities of utilizing the heat of the garbage furnaces. Largely on the basis of English figures, it is concluded that 1 lb. of refuse will evaporate 1 lb. of water. Allowing for a consumption of 10% of steam by the forced draft injectors and a loss of 15% in motive power other than dynamos, it is estimated that a total of about 2,500 HP. would be available for electric light and power, a portion of which would be needed in and about the several plants.

The specifications submitted with the report call for one 300-ton, two 200-ton and two 50-ton plants, to be installed by the contractor on land furnished by the city. The plants must include everything needed for the cremation of garbage, and all necessary buildings. Bidders are to furnish plans and specifications and make bids for plants both with and without provision for the utilization of heat. No proposals for systems not approved and tried by important cities will be considered.

An interesting and unique feature of the specifications is a provision that within 30 days from the time of opening bids and before the awards are made each bidder must construct a trial furnace. If the furnace unit proposed has a capacity of 20 tons, a trial furnace of eight tons will be accepted. The trials will last for three months, and at the discretion of the Commissioner of the Common Council may be extended to a total length of six months. The city will supply each furnace with garbage. The furnaces will be under the direct charge of the respective bidders, but the test in general will be under the control of a special commissioner. The chief object of the tests will be to determine the weights of garbage consumed daily; the composition of the cinders and ashes, and the gases prior to combustion, within the furnaces, and in the flues at the base of the chimney; and the quantity of water evaporated per unit of garbage.

At the conclusion of the tests the special commissioner will report on the plans and specifications submitted by the various bidders, together with the results of the tests. This report will go to the Common Council, which will thereupon accept some one of or reject all the bids, as it sees fit. If an award is made, the Council may exclude the two 50-ton plants.

The city will reimburse the unsuccessful bidders for the cost of all the trial furnaces which prove efficient for the burning of garbage.

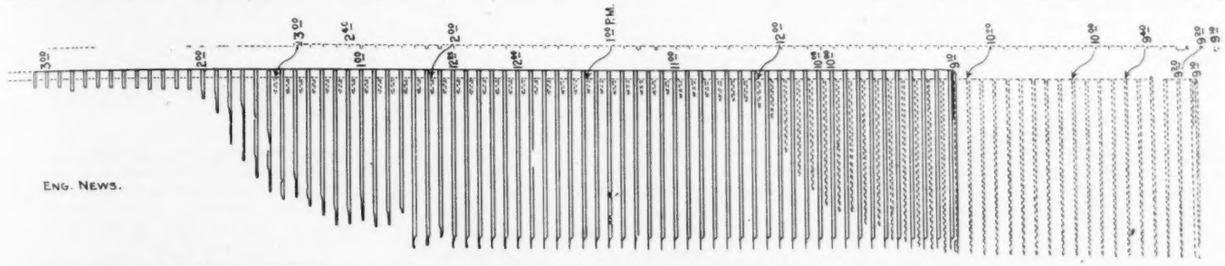


FIG. 2. DIAGRAM FROM AUTOGRAPHIC TESTING MACHINE, SHOWING A TEST OF THE RATE OF SET OF EMPIRE PORTLAND CEMENT.

(Temperature of air 70° F.; amount of water used in mixture 3.8% by weight. Broken lines represent the rate of initial set as shown by a needle 1-12-in. in diameter and weighted to ¼-lb.; full lines show rate of set (final) as indicated by a needle having an area of 1 sq. mm., and weighted to 300 grams.)

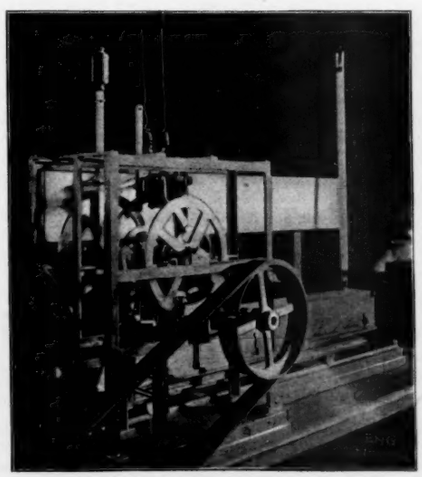


Fig. 1. Autographic Testing Machine for Determining Rate of Setting of Cement Mortars. Edgar B. Kay, Ithaca, N. Y., Inventor.

A MACHINE FOR INVESTIGATING THE RATE AND TIME OF SET OF CEMENT MORTARS.

By Edgar B. Kay.*

An interesting autographic machine has been recently installed in the Cement Laboratory of the College of Civil Engineering, Cornell University, for the use of students in investigations of the physical properties of cements, limes, etc., and especially for the study of the time and rate of set of cements. Fig. 1 is a general view of the machine, and Fig. 2 is a reduced fac-simile of the autographic record made by it in actual tests.

The machine is operated at any desired speed, by a small Pelton motor, and when adjusted for a test records automatically the rate and time of setting of the cement mortar. A needle controlled electrically and connected with the laboratory clock, records five-minute intervals on the diagram as the test proceeds, which serves as a check in platting the curves, if there should happen to be a variation in the speed of the motor at any time. This arrangement, in fact, permits the machine to be operated at a variable speed, and from the diagrams obtained a new diagram can be platted for any desired intervals during the period of setting. For Portland cement, the machine is ordinarily run, so that the test needles come in contact with the cement mortar, once in five minutes. Each needle has a vertical travel of 72 mm. and a penetrating limit of 67 mm. The needle bars are operated by cams, which lead the needles to the surface of the mortar slowly and do not permit them to acquire momentum while passing through the mortar. When the machine is set for five-minute tests, the amount of time required by the needle, from the time it begins to descend until it has reached the lowest point of penetration, is

*College of Civil Engineering, Cornell University, Ithaca, N. Y.

about 20 seconds. When the mortar has reached a stage of set sufficient to retard the progress of the needle, the amount of penetration is recorded, by means of a pen attached to a needle bar, which is delicately adjusted, so as to prevent retardation as it travels up and down the well-calendered paper fastened to the diagram board attached to the frame of the carriage. The needle bars are interchangeable and any desired diameter of needle can be used, or different weights can be employed.

In the tests that have thus far been made with the machine, one needle bar, including needle and pen, weighs 300 grams, and the needle has a uniform sectional area of one square millimeter, conforming to the German and French practice as to area, although the needles used on this machine are circular in section, while some of the French specifications call for a needle square in section. The second needle bar, needle and pen weigh ¼-lb., or 113.4 grams, and the needle has a uniform diameter of 1-12-in. (2.1166-mm.), or a sectional area of about 3.5 sq. mm., conforming to the American practice for the determination of initial set. The needle bars are square in section, and have an area of 56.25 mm.

The cement box is 5 cm. wide, 72.4 cm. long, and 7 cm. deep in inside dimensions. The carriage is 42 cm. c. to c. of track wheels; and the top of the carriage is 63 cm. by 12.5 cm. The diagram frame is attached rigidly to the carriage. The carriage is operated by means of a rack and pinion, the pinion being driven by an eccentric communicator from one of the cam shafts. While the needles are in motion, or are free to move, the carriage is at rest. The travel of the carriage, carrying the mortar box for each penetration is 6 mm. The track is 1.35 m. long with a gage of 8 cm.

The mortar box, which is made of brass plates easily taken apart, and having the upper surfaces in a horizontal plane, enables the mortar to be brought to a plane surface before the test begins. The mortar box is placed between guides, that hold it securely, and the guides are so arranged that the box can be shifted from one side of the carriage to the other, which permits the needles to be applied near the edge of the box, or in the center of the mass of mortar, as desired. The mortar box holds about 5 kilos. of Portland cement. All cement before being tested is carefully sifted through a sieve of 10,000 meshes per square inch.

The machine is made entirely of brass, except the base and track, which are of cast iron, and was constructed from the designs of the writer, upon the suggestion and under the direction of Dean E. A. Fuertes, at the Mechanical Laboratory of the College of Civil Engineering, by Mr. W. O. Stubbs, Mechanician.

The tests that have been made in the short time the machine has been in use, have proven most interesting, and the curves obtained differ materially from those published by Tetmajer. The machine is also designed for use in testing the time and rate of set of mortars submerged in liquids.

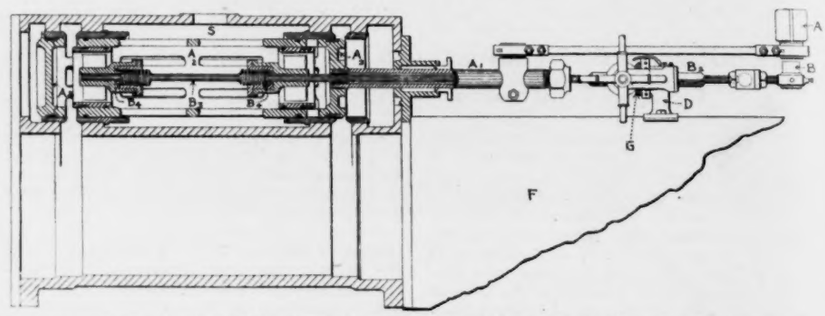
BUCKEYE ENGINES WITH CUT-OFF ADJUSTABLE BY HAND.

Engineers have so long been accustomed to the attachment of a speed regulating governor to stationary engines that it is well-nigh forgotten that an automatic governor is not after all an essential part of an engine. For certain locations it is an advantage to control the speed and output of such an engine by hand adjustment, just as the engineer controls the speed of a locomotive or a hoisting engine.

An example of this sort is furnished by the engines direct-connected to blowers or exhausters for moving air or gas. Here there is almost no possibility of the engine suddenly losing its load and running away. The load is absolutely steady, but is required to be varied occasionally within wide limits. Small engines of this class have usually been built with a throttle-valve regulation. The trouble with this is that the throttle must be set to give when necessary the full power of the engine, and at all ordinary loads the steam is wire drawn with a large loss in efficiency. Instead of this, if an engine is built with a cut-off valve adjustable by hand, the steam can be worked expansively at all loads short of the extreme capacity of the engine. It will be evident that such a device may be much more simple and inexpensive than the ordinary flyball or flywheel governor with its apparatus for automatically adjusting the point of cut-off.

Some engines of the above-described sort have recently been built by the Buckeye Engine Co., of Salem, O., for the Consolidated Gas Co., of New York city, and are to be direct-connected to positive pressure exhausters. The method by which the hand adjustment of the cut-off is effected is made clear by the accompanying cut, which shows a section of the cylinder, valve-chest and valve motion of a Buckeye engine.

As seen, the Buckeye valve mechanism consists of a cylindrical or piston valve having a fixed point of cut-off. The riding or adjustable cut-off valve is inside the main valve. A fixed eccentric on the main shaft drives the rocker-arm A, which communicates its motion to the main valve stem A_1, driving the main valve A_2. A second eccentric on the main shaft drives a rocker-arm B, which operates the riding or cut-off valve. To adjust the point of cut-off, the mechanism used consists of right and left-hand threads combined with means for rotating the valve stem. These right and left-hand threads are shown at B_4, and operate to vary the distance between the lips of the cut-off valve. The rotation of the valve stem while the engine is running is effected as follows:



SECTION THROUGH CYLINDER, STEAM CHEST AND VALVES OF BUCKEYE ENGINE, SHOWING HAND REGULATING DEVICE ON CUT-OFF VALVE STEM.

Built for the Consolidated Gas Co., New York, by the Buckeye Engine Co., Salem, Ohio.

The valve stem is squared at the point B_2 and plays through a square composition bearing supported from the frame of the engine by a bracket D. This bearing is so connected to a hand-wheel and a pair of gears that it can be rotated, carrying, of course, the whole valve stem with it.

To hold the valve at any fixed cut-off, a collar on the valve stem guide, shown at G, has holes drilled in its circumference into which a spring latch enters. This not only locks the mechanism in place, but indicates the point of cut-off, numerals being stamped on the collar for this purpose.

It should be noted that the sketch from which the illustration is made is designed to show merely the general idea of the device, and is not absolutely accurate in its details of the valve construction, etc.

This adjustable cut-off was in part designed by Mr. Paul Bigelow, the New York representative of the Buckeye Engine Co., to whom we are indebted for the information from which the accompanying article was prepared.

A METHOD OF WATERPROOFING BLUE PRINTS is described in a recent issue of "Mines and Minerals," as follows:

Immerse in melted paraffin until saturated a number of pieces of an absorbent cloth a foot or more square; and, when withdrawn and cooled, they are ready for use at any time. To apply to a blue print, spread one of the saturated cloths on a smooth surface, place the dry print on it with a second waxed cloth on top, and iron with a moderate flatiron. The paper immediately absorbs paraffin until saturated and becomes transiucent and highly waterproof. The lines of the print are intensified by the process, and there is no shrinking or distortion. As the wax is withdrawn from the cloths, more can be added by melting small pieces directly under the hot iron. By immersing the print in a bath of melted paraffin the process is hastened, but the ironing is necessary to remove the surplus wax from the surface, unless the paper is to be directly exposed to the weather and not to be handled. The irons can be heated in most offices by gas or over a lamp, and a supply of saturated cloths obviates the necessity of the bath. This process, which was originally applied to blue prints to be carried by the engineer corps in wet mines, is equally applicable to any kind of paper, and is convenient for waterproofing typewritten or other notices to be posted up and exposed to the weather.

THE PRODUCTION OF IRON ORE in the United States during 1900, according to figures recently compiled for the U. S. Geological Survey, was 27,553,161 gross tons as compared with 24,683,173 gross tons in 1899. The production by states and territories is given in the following table:

States and Territories.	Gross tons.
Michigan	9,920,727
Minnesota	9,834,399
Alabama	2,759,247
Virginia and West Virginia	921,821
Pennsylvania	877,684
Wisconsin	796,105
Tennessee	594,171
New York	141,485
Colorado	407,084
New Jersey	344,247
Georgia and North Carolina	336,186
Montana, Nevada, New Mexico, Utah, Wyoming	132,277
Ohio	91,016
Kentucky	82,920
Missouri	41,366
Connecticut and Massachusetts	31,185
Maryland	20,223
Texas	16,881
Iowa	2,137
Total	27,553,161

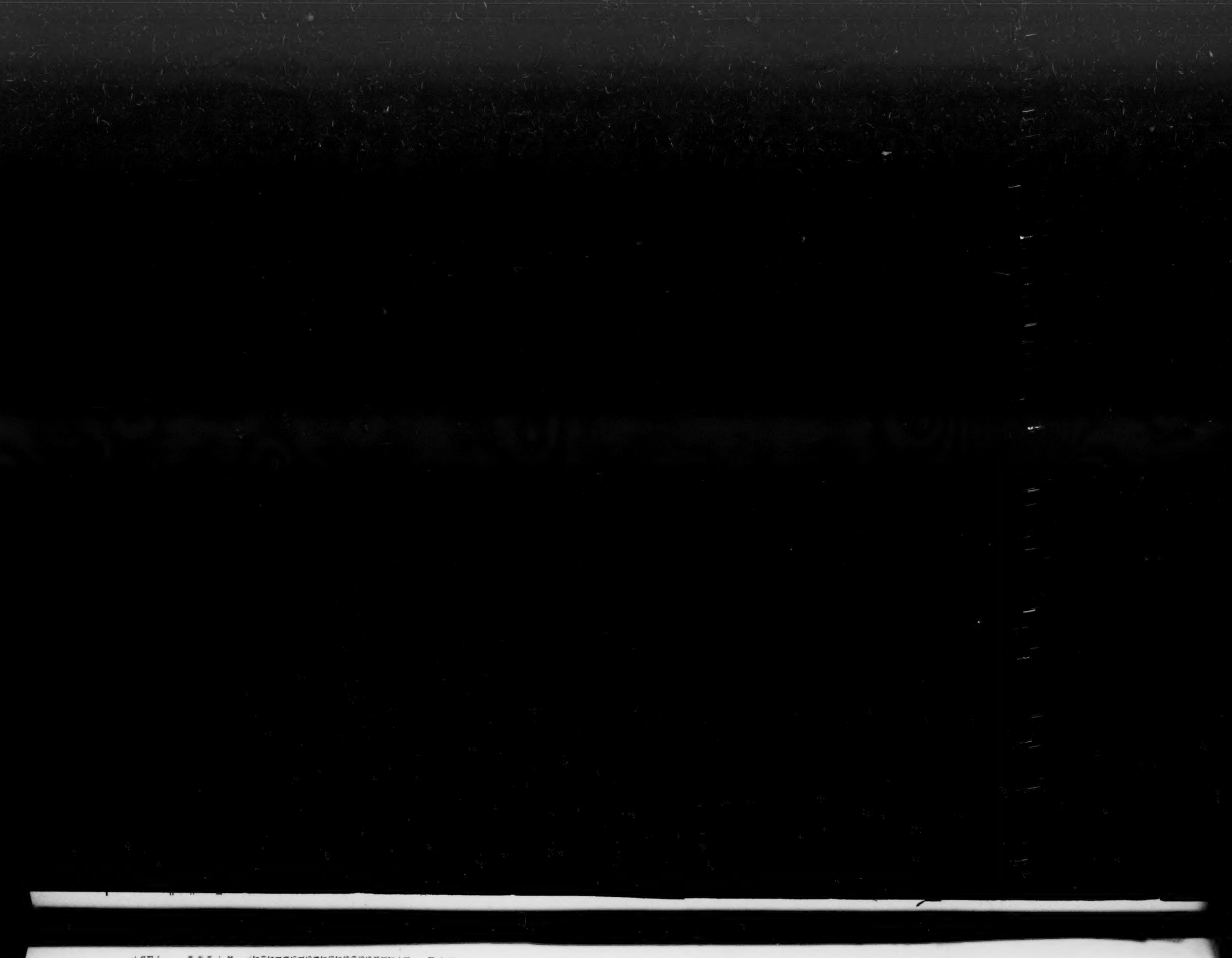
THE EXPORTS OF RAW COTTON from the United States for the fiscal year just closed were valued at $313,673,443, the largest on record. The next best record of $290,712,898 was made in the fiscal year of 1891. The total cotton exports for the past year were $365,405,707, made up as follows: Raw cotton, $313,673,443; cotton manufactures, $20,272,418; cotton seed oil, $16,541,321; cotton seed meal, $13,119,968; cotton waste, $1,431,609. Cotton seed was exported to the value of $366,953.

THE PIG-IRON PRODUCTION for the first six months of 1901 was 7,674,613 tons, according to figures recently published by the American Iron and Steel Association. The following is a statement of the production classified according to its uses:

Foundry and forge iron	2,311,401
Bessemer pig	4,682,187
Basic pig	645,105
Ferro-manganese and spiegeleisen	135,920
Total	7,674,613

THE CALUMET RIVER IMPROVEMENTS, outlined in the annual report of Major Willard, U. S. Engineers, in charge of the Chicago district, include the dredging of the river to a depth of 21 ft., which will require some rock excavation at 112th St. Three turning basins are also recommended. The report states that the combination of three railway swing bridges which have to be opened on the same signal is exceedingly bad, and is the cause of much friction and delay to traffic. It is recommended that these bridges be replaced by a six-track bascule bridge, under one management.

BOOK REVIEWS.

THE STATISTICAL YEAR-BOOK OF CANADA for 1900.—16th year of issue. Issued by the Department of Agriculture, Ottowa, Canada. Paper; 6 × 8¾ ins.; pp. 641; map.

This statistical summary is edited by Mr. George Johnson, F. S. S., Statistician of the Department of Agriculture. After giving a short history of the Dominion of Canada and a list of its officials from 1534 to date, it treats of its lands and land regulations, its agriculture, minerals, fisheries, trade and commerce, currency and banking, railways and canals, marine, insurance, education, public institutions, Indians, etc. The larger mass of its contents are in tabular form, covering long periods of years.